Semiotic repertoires in bilingual Science learning:

a study of learners' meaning-making practices in two sites in a Cape Town high school.

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Thesis presented for the degree of

Doctor of Philosophy

In the School of Education

Faculty of Humanities

University of Cape Town

December 2018

Plagiarism declaration

I, Robyn Lucy Tyler, declare that this thesis is my own work, undertaken with the normal guidance of my supervisor.

I have specifically and appropriately attributed the ideas and words of others contained therein using the American Psychological Association (APA) 6th edition referencing style.

This work has not been submitted in whole or in part for any other degree at the University of Cape Town or elsewhere.

Signed by candidate

1 December 2018

Acknowledgements

First and foremost, I acknowledge the outstanding support and guidance of my supervisor, Carolyn McKinney. I admire and thank you for your excellent scholarship, your empowering mentorship, and your unfailing integrity.

In addition to Carolyn, I have benefitted from a truly supportive PhD community in the School of Education at UCT. Soraya, Xolisa and the Thula Ubhale and OBUESA groups, thank you for your friendship, for sharing this journey with me and for teaching me how to take a selfie. I have also been very fortunate in transcribers and translators. Juliette and Babalwa, your skills have been indispensable and I really enjoyed working on the data with you. Ndiyabulela boosisi. I also am indebted to the Interlibrary Loans department at UCT – you have managed to fulfil my every request for far-flung literatures with such efficiency. Thank you to my three examiners whose careful comments have helped me to refine this study.

I am grateful for the ample funding granted for three-and-a-half years by the National Institute for the Humanities and Social Sciences (NIHSS) who have also provided useful academic training through seminars and conferences.

Completing a doctorate with young children in one's life is a task which some might quail at. Fortunately for me I had my eternal fore-runner, my big sister, to show me the way. Thank you, Em, for sharing the ups and downs and the childcare. You have been an invaluable support. The circle of back-up and love has included Emily, an extraordinary granny Teen and top-draw uncle Glen, Vuyo – holder of the fort and my favourite isiXhosa teacher – Grandpa and Linda, and of course the never-complaining and ever-supportive Mark. Family and friends rallied to help with proof-reading: Campbell, Christine, Glen, Emily, Jenn, Kirsty, Ciska and Melanie. Thank you all.

Last, but not least, I acknowledge the generosity and openness of the Success High community, in particular the Principal, Ms B and the learners of 9B, in hosting me and my cameras. Bafundi, writing up this dissertation is so far from the cut and thrust of learning Science and isiXhosa with you all. Thank you for your freshness, energy and fun. You will go far. Mna, ndiyithandile ukuhamba nani.

My darlings: Erin, Georgia and Mark…it's time to celebrate!

Dedication

To the young people of 9B.

And for Georgia and Erin.

Abstract

Bilingual minoritised youth face challenging conditions for learning Science in South African schools. Among these are restrictive school-level language policies; entrenched monoglossic language ideologies within the education system which play out in classroom practice; and a lack of learning and teaching materials in African languages. Despite these challenges, learners work daily to make meaning in specific Science topics. It is this meaning-making process which is the focus of this case study.

The study proceeds from the view of language as one of multiple semiotic resources comprising an individual's semiotic repertoire which they draw upon to make meaning. Further, following Bakhtin, an understanding of the inherently heteroglossic nature of language is brought to bear on the learners' bilingual practices as they journey along a meaning trajectory through a Science topic. These practices are described taking up the recently developed term 'translanguaging' and Angel Lin's 'trans-semiotizing' with the theoretical work of these terms being extended to include different registers as well as named languages and modes.

A case study employing the tools and perspectives of linguistic ethnography was undertaken for a period of nine months in a high school in Khayelitsha, Cape Town. The author joined a Grade 9 (13/14 year olds) class as a participant-observer during their study of the topic 'Chemical Reactions' and facilitated a study group with volunteers from the class of 36 learners. Interactional data from multiple sources of audio and video recordings was collected from ten Natural Science lessons and eight study group meetings. Learner texts, school policy documents, photographs, interviews with staff and questionnaires were also employed to enable analysis of the language environment of the school and microethnographic analyses of the multimodal interactional data.

Building on the taxonomies developed by scholars of social semiotics working in Science learning contexts (Jay Lemke, Eduardo Mortimer and Philip Scott, Gunther Kress and Carey Jewitt) three broad categories of learner meaning-making are identified in the data: *constrained*, *guided* and *spontaneous* meaning-making. Forming the major theoretical

contribution of this dissertation, these categories serve to provide a framework for understanding learners' meaning-making – conceptual development as well as identity work - in monolingual and/or bilingual contexts. Key insights from the data analysis include that while constrained meaning-making can facilitate the *acquisition of fixed words* in scientific discourse, guided and spontaneous meaning-making are required for discourse *appropriation* and flexible expression of scientific ideas, often through a meshed register. Further research and teaching practice attention focused on *guided* and *spontaneous* meaning-making in content subjects drawing on multiple modes is argued for.

Contents

Abbreviations

IRE – Initiation, Response, Evaluation: triadic discourse structure

LoLT – Language of Learning and Teaching

CAPS – Curriculum and Assessment Policy Statement

NS – Natural Science

WCED – Western Cape Education Department

LIEP – Language in Education Policy of 1997

SG – study group meeting

C – class lesson

TIMSS – Trends in International Mathematics and Science Study

DBE – Department of Basic Education

SFL – Systemic Functional Linguistics

LTSM – Learning and teaching support material

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1 Background

> *Science is not limited to one culture, one dialect of English, or one style of communication. Science teaching today is.*
>
> - Lemke, 1990, p.138

Introduction

In 2018 questions of language in education in South Africa have taken on an urgent tenor. Social movements such as university students calling for decolonised education with equitable access for all (Rhodes Must Fall, 2015); citizens demanding their rights to quality education from a system which has failed to deliver this for the majority of children (Case Consortium @ Columbia, 2014) and school students protesting discriminatory school policies[1] (Christie & McKinney, 2017) have captured the public imagination. These social movements are contemporaneous with South African Education research on language-related topics such as:

- policy and ideological conditions relating to language use in our schools (cf. McKinney, 2017; Probyn, 2009)
- language-related barriers to learning (cf. Mayaba, Otterup & Webb, 2013; Setati, Adler, Reed & Bapoo, 2002; Howie, 2003)
- effective pedagogies for learning in our multilingual schools (cf. Makalela, 2015; Msimanga, Denley & Gumede, 2017; Nomlomo, 2007; Ramadiro, 2017)
- subversive and creative language practices under highly constrained teaching and learning conditions. (cf. Banda, 2010; Kerfoot & Bello-Nonjengele, 2014; Krause & Prinsloo, 2016)

This South African scholarship is ongoing concurrently and at times interwoven with a global corpus of applied linguistic studies of language in educational settings. This international scholarship has been particularly pressing in the light of global social change, due to migration

[1] During my fieldwork, some Cape Town schools experienced protests over hair and language policies and due to this the school closed early one day as a safety measure – a sobering reminder of the urgency of the social issues which this study aims to address.

and displacement resulting in complex multilingual social contexts. Assumptions about best practice with regards to language for learning - and at times the notion of language itself - have been challenged. Scholars are concerned with far-reaching questions such as:

- What is language?
- What counts and what should count as language for learning?
- How should language concerns influence curriculum design and vice versa?

The present case study addresses a number of gaps in this research and extends some of its concerns. On a theoretical level, the study contributes to the conceptualisation of minoritised bilingual youth's meaning-making resources for learning through taking up the notion of semiotic repertoires. The study of semiotic repertoires broadens our view of the meaning-making of bilinguals[2] (Lin, 2015; Kusters et al., 2017) giving a more comprehensive picture of what is involved in learning. Likewise, the study extends the work that applied linguistic terms such as 'translanguaging' (García & Li Wei, 2014; Creese & Blackledge, 2010) and 'trans-semiotising' (Lin, 2015) do by providing microethnographic (Bloome et al., 2005) analyses of interactional data in two learning settings. These analyses demonstrate the identity work that bilingual learners perform and the kinds of meanings that are made through the texts which they produce, while linking this meaning-making to the ideological milieu which informs it. On a practical level, the insights from this study seek to contribute to solving a persistent problem in South African schooling: the lack of recognition, and at times outright rejection, of the semiotic resources that our children bring to school, resulting, in part, in the widespread failure of our children within the system.

The remainder of this chapter will describe my interest and experience in language in education in South Africa; introduce the research problem which the study will address; and give an overview of the study through outlining the extent of the fieldwork which I undertook in Success High[3] in 2016. In conclusion, I will state the research goals and questions which frame the study.

[2] The choice of this descriptor of the main participants in my study is a move to position these learners as resourceful and capable in their learning, rather than as a linguistic description of their having only two named languages in their repertoire.

[3] The name of the school as well as all participants except myself have been changed.

Personal interest and experience in language in education

My interest in and enjoyment of language has always been with me. As a child I was an inveterate word-mangler[4] and loved to play the fool with words. I have been exceptionally fortunate to have been educated through my home language, English, throughout my schooling and tertiary studies. I studied the compulsory English and Afrikaans subjects at school and opted to fill one of my elective slots with isiXhosa at high school in Cape Town– an option which was a rarity in 'Model C'[5] schools such as mine in the 1990s. With the addition of History, I displayed a strong humanities preference over the sciences. During my undergraduate degree I took a course in Linguistics and had a major in English. I completed my training as a high school English teacher in 2000. During my seven years of English teaching in South Africa and the United Kingdom it was often the 'language' as opposed to the 'literature' parts of the English curriculum which intrigued me, particularly the moments when my students challenged the curriculum's dogma on 'accuracy' and 'appropriateness' in language use – an early indication of my alignment with the 'multilingual turn' (May, 2014) in applied linguistics. More significant for further study, though, was my interest in the struggles faced by learners with home languages other than the dominant language of the schools in which I taught (English). I pursued this interest through my English Honours and Masters dissertations. When I embarked on my Honours project my questions about language in education were focused on understanding the experience of learners whom I called 'English additional language learners' in an English dominant school as well as the attitudes of their teachers towards them. My ideological and theoretical focus had shifted in my Masters in which I positioned my participants as 'bilingual learners' and along with their Mathematics teachers studied the discourse for learning Mathematics in their rural classroom. With new theoretical tools at my disposal and a developing identity as an advocate for social justice through language in education, I embarked on this doctoral project which is concerned with both prevailing bilingual practices in high school Science learning and interventions which

[4] This term was coined by my fellow word-mangler and husband, Mark, and relates to the irreverent disregard for 'standard' rules of syntax and semantics.

[5] 'Model C' refers to well-resourced schools which under Apartheid were reserved for white children and post-transition to democracy became 'open' to all races. For the history of the Clase Models for schools created during the transition from Apartheid to democracy see Christie, 1995.

might offer new opportunities for social justice (Piller, 2016) and decoloniality (Ndlovu-Gatsheni, 2015; Maldonado-Torres, 2007; Mignolo, 2007, 2009, 2011) through learning.

Research problem

Language policy and use in South African schooling

The history of schooling (but not education[6]) in South Africa, as in all parts of Southern Africa, is a colonial history. The first schools were set up by the Dutch and then the British when they settled in the Cape. These schools were opened to serve the white[7] settler population and were not intended for the indigenous or slave populations whom the colonists had subjugated. Many schools for white children were started by one or other denomination of the church which later went on to provide 'missionary schools' for the indigenous African people. It was at one such school where the world icon, Nelson Mandela, began his formal education.

By the time Apartheid was formalised into a political system, the children of white colonists and the indigenous children were schooled separately, with the indigenous African children receiving a far inferior education to their white peers in terms of resource allocation and curriculum. This inferior schooling system was formalised in the Bantu Education Act of 1953. In this system, schools for black African children were designated with spare facilities and a curriculum which aimed to prepare them for a life of servitude to their white masters (Christie, 1991). The language policy of these schools was home language medium of instruction until Standard 6 (approximately 13 years old or 7 years of primary plus 1) with the official languages of the Apartheid state, English and Afrikaans, being studied as language subjects. After Standard 6 subjects were taught in English and Afrikaans until the last year of high school. This situation was particularly oppressive to black learners who were considered second-class citizens by the state in every aspect of their lives. Children as young as 13 protested against the use of Afrikaans in their schooling in the infamous Soweto uprising of

[6] I conceive of the education of children as occurring in formal and informal contexts, while schooling refers to only the formal contexts of educating children.

[7] Following Swartz (2009, p.185), I acknowledge that the category of race is a social construction, employed by the Apartheid regime to classify people into groups such as 'African' (also termed 'black') and 'white'. I use these terms uncomfortably in order to describe continuities between the past and present.

1976 after which the state relented and scrapped Afrikaans-medium education for black South Africans. White children, such as myself, received their schooling in their home language throughout their school years: Afrikaans for Afrikaans speakers and English for English speakers[8], with a strong emphasis on bilingualism through the teaching of the other 'white' language as a subject in all years. This situation continues mostly unchanged today for white children.

With the dawn of democracy in 1994, the writers of the new constitution were tasked with creating new language policies. The most pertinent for this study is the Language in Education Policy of 1997 (LiEP). While viewed as progressive and enabling of multilingualism (Probyn et al, 2002; Heugh, 2002; Pluddemann, 2009; Alexander & Cherry, 2012), the policy was flexible enough with the inclusion of practicability clauses (Department of Education, 1997) that in most schools the status quo of language policy remained unchanged. The policy requires that the Language of Learning and Teaching (LoLT)[9] be any official language of South Africa and that each learner should offer two languages as a minimum as subjects (Department of Education, 1997). For white children, this meant that they were not compelled to learn an indigenous African language as they opted for their home language and the other dominant language of the white community (ie. English or Afrikaans). For black speakers of indigenous languages this meant that in most cases they offered their home language and English, with English being offered as LoLT from Grade 4 for the majority of learners.

The dominance of English as LoLT was entrenched by the new Curriculum and Assessment Policy Statement (CAPS) in 2011. The English Additional Language CAPS assumes a switch to English LoLT in Grade 4 and argues from this basis for the development of good English literacy in the Foundation Phase:

> In South Africa, many children start using their additional language, English, as the Language of Learning and Teaching (LoLT) in Grade 4. This means that they must reach a high level of competence in English by the end of Grade 3, and they need to be able to read and write well in English. For these reasons, their progress in literacy must be accelerated in Grades 2 and 3. (Department of Basic Education, 2011a, p.8)

[8] A significant minority received bilingual education in one form or another (Malherbe, 1946)
[9] LoLT replaced the concept 'medium of instruction' with the introduction of Outcomes Based Education in 1997. In practice, English LoLT means English for assessments and in LTSMs, with its oral use varying from classroom to classroom.

This has placed the speakers of African languages at a distinct disadvantage to their white counterparts, given that international literature has attested to the importance of using children's home languages as media of instruction for at least the first six years of formal schooling (Thomas & Collier, 1997; Bamgbose, 2000; UNESCO, 1953). Not only this, but African language speaking children are also severely limited in their exposure to English at school before they make the switch to English as LoLT in Grade 4. The subject English Additional Language is allocated 2/3 hours per week in Grade 1 and 2 and 3/4 hours per week in Grade 3 (Department of Basic Education, 2011a). Scholars have argued that this is far too little to prepare children for coping with the content subject demand and accompanying vocabulary and academic language structures in English from Grade 4 (Macdonald, 1990).

The continuities with the past extended especially in the lack of materials development and assessments in African languages thereby constraining the choices that the School Governing Bodies (SGBs) tasked with drawing up language policy could make. School language policies tend to be simple, brief and not widely consultative if they exist in writing at all (Probyn et al, 2002) with little care given to the exhortation in the LiEP to 'stipulate how the school will promote multilingualism' (Department of Education, 1997, p.3). The majority of schools opt for one language of learning and teaching (LoLT) which is usually English and that is the end of the policy pertaining to LoLT. Heugh (2002) found that when parents were offered their home language alongside English as a LoLT they were much more in favour of including their home language than if they had to choose between English and the home language. Another continuity with the past is how practice in classrooms flouts policy, particularly the ideology of languages as separate, bounded entities which pervades the LiEP. Scholars have written about code-switching, translanguaging, 'smuggling in the vernacular' and many other creative and productive language practices in South African classrooms. While these practices have been lauded by researchers as important for conceptual and identity development (Krause, 2014; Probyn, 2016; Tyler, 2016; Guzula, McKinney and Tyler, 2016), they remain illicit and dilemma-filled concessions, with their users often expressing guilt in relation to their practice. The majority of South African classrooms function as 'adaptive translanguaging spaces' (García & Li Wei, 2014, p.133) in which translingual practices are used spontaneously without systemic supports or connections being made between the more familiar ways of using

language and the academic registers which all school children need to learn. A review of bilingual classroom discourse studies in South Africa can be found in Chapter 2.

A further stratification of language policy for black South Africans occurs along class lines. As Prof. Mamokgethi Phakeng quipped in a recent seminar, 'If you have money, you can buy English' (Phakeng, personal communication, 2017). Children with African language backgrounds who attend wealthy 'Model C' schools surrounded by home language speakers of English find themselves in an immersion language learning situation and often learn English quite quickly, although their home languages are rarely supported at school. Children in rural or peri-urban townships do not have such ready access to English and therefore labour more than their middle-class counterparts under an English-only LoLT policy with the goals of their schooling being 'reduced to learning English and memorisation' (Christie & McKinney, 2017, p.172).

As a response to the lack of uptake in 'Model C' schools of the exhortation in the LiEP for schools to address multilingualism, the Department of Basic Education (DBE) introduced a draft policy in 2013 called the Incremental Implementation of African Languages policy (IIAL) (Department of Basic Education, 2013). The aim was to introduce the teaching and learning of African languages in schools where currently only English and Afrikaans were formally taught. The 'policy' has since been downgraded to a 'strategy' and participating schools do so voluntarily and without any financial support from the DBE (Western Cape Education Department minute, 2017a). The IIAL is not an instrument for increasing epistemic access for the majority of our learners to the content of their education through admitting their language resources into schools as LoLT, but rather introduces African languages as subjects. This is already the status quo in schools where the majority of our African language-speaking learners attend and so the IIAL can only function to address the lack of multilingualism in privileged 'Model C' schools.

The language policy pertaining to LoLT, with the recommendations in the CAPS documents that all children switch to English LoLT in Grade 4, has had implications for learning and teaching support materials (LTSM), most notably textbooks. For content subjects, the textbooks from Grade 4 onwards are still only available in either English or Afrikaans (with remnants left over from the Language Transformation Plan in Western Cape up to Grade 6).

Despite the lack of political will to include African languages in content subjects beyond Grade 3, there is a small but vocal lobby for this to happen. The promotion of the use of African languages in schooling is part of a wider lobby for the "intellectualisation"[10] of African languages in general (Finlayson & Madiba, 2002). One of the strategies towards achieving this goal has been the drawing up of multilingual glossaries[11] with the aim of assisting learners in content subjects.

The oral use of African languages in schools is mostly characterised by the DBE pejoratively as 'code-switching'. It has recently been explicitly discouraged and the sole use of English after Grade 3 promoted in official communication to schools (Western Cape Education Department, 2014a, 2017b):

> It is imperative that all learners are maximally exposed to the LoLT to be able to gain sufficient mastery in order to communicate effectively in both written and oral communication. Schools are requested to reduce the amount of code switching and code mixing in order to ensure maximum exposure to the LoLT as the language of assessment. (Western Cape Education Department, 2017b, p.1)

This imperative ignores the research on the cognitive and affective benefits of trans- and multilingual language use (including code-switching) and positions as deficient a teaching and learning practice born out of a constraining language environment in schools. At the same time, apart from demanding 'maximum exposure' to the LoLT (English), the WCED communication does not offer teachers detailed support in negotiating a curriculum in what for most learners is a language only used in school.

A review of the official statistics of LoLT types in the Western Cape (Western Cape Education Department, 2015, personal communication) is illustrative of the position of the research site, Success High, in relation to Western Cape schools in general. Of the 1683 registered public and private schools in the Western Cape in 2015, single LoLT schools are in the majority (614 Afrikaans, 436 English - including Success High - and 1 French). Three multiple LoLT models are also recorded: dual medium, parallel medium and multiple medium. Dual and multiple

[10] While this is a term in general use, I use scare quotes here to distance myself from the assumption that African languages have not always been used for intellectual pursuits.
[11] For examples see Wababa (2009), Department of Basic Education (2013), Madiba (2014) and Carstens, Taljard & Madiba (2016).

medium refer to schools where all learners are exposed to more than one LoLT. The only dual medium model is Afrikaans/English (72) and the only multiple medium is Afrikaans/English/isiXhosa (26). Parallel medium refers to learners being taught separately according to LoLT or different LoLTs being in operation in different grades at the same school. Here African-language dominant schools are typical where there is a switch from African language LoLT in Grades 1-3 to English from Grade 4. There are six types of parallel medium schools: Afrikaans/English, German/English, isiXhosa/English, English/SeSotho, Afrikaans/isiXhosa, Afrikaans/English/SeTswana.

While these definitions cannot tell us much about the linguistic realities of the classrooms they describe – and indeed this thesis rejects the notion of a named language as a linguistic reality - they can give an indication of which linguistic resources are valued by virtue of their inclusion in official policy choices which are registered in the WCED database. In the 2011 South African census, 24.7% of people in the Western Cape identified isiXhosa as their home language (Statistics South Africa, 2012). Significant for the isiXhosa-English bilingual children in the current study is that their home language resources are recognised as vehicles for learning in official policy in only 172 schools (10%) and of these none offer isiXhosa as LoLT beyond Grade 4.

The poor offering of home language education for African language speakers in the Western Cape was addressed in the 2007 WCED language transformation plan (Western Cape Education Department, 2007) – an initiative which was piloted in 16 schools but never fully implemented and then abandoned[12]. LTSMs were published in isiXhosa from Grade 4 to 6 during that time but are now out of print. The two language strategies published by WCED since 2010 (IIAL and the Language Strategy 2015-2019) have been focused on languages as subjects and have left unaddressed the academic and identity challenges that African language speaking learners in the Western Cape face in learning through English only. These challenges were brought front and centre by the learner-led protests of 2016. Having begun in Pretoria, the protests soon ignited in Cape Town at Sans Souci girls' high school (see Christie

[12] This Language Transformation Plan was 'abandoned' for political reasons after the change of regional government from ANC to DA in 2008. This was despite the fact that all 16 schools showed remarkable improvement in results. The Western Cape Education Department under the ANC had been planning to roll out Mother Tongue instruction to Grade 6 in 2009 to the remaining 40+ schools in the Province which had multilingual profiles (Caroline Kerfoot, personal communication).

& McKinney, 2017). Key to the Sans Souci protests was the issue of isiXhosa being banned from use anywhere on school premises and even off-site when girls were wearing the school uniform.

Conceptualisations of language and literacy in school Science

Moving on from language in South African schooling in general, I now turn to the conceptualisations of language and literacy in school Science subjects specifically. South African learners' poor performance in Science has been highlighted by studies such as the Trends in International Mathematics and Science Study (TIMSS) as well as by the annual matriculation[13] results (Campbell & Prew, 2014). Howie (2003), analysing the results of TIMSS 1999, pointed to language issues as being a major factor in learners' poor performance. The test is written in English, the home language of less than 10% of South Africa children. Howie concurs with many other South African scholars who have blamed the mismatch between the home language of children and the language of Science taught at school for the poor performance of learners (Macdonald, 1990; Mayaba et al 2013; Msimanga et al., 2017). While these studies and others have drawn attention to the role of language in learning Science, language and literacy have long been side-lined in discussions of quality Science teaching and learning. A 2004 edited volume entitled, 'Crossing borders in literacy and science instruction: perspectives on theory and practice' sought to ameliorate this situation in the United States by bringing into conversation the research fields of Science education and literacy. The need for this book highlights the separation of these fields traditionally. In the book, scholars working across both fields argue convincingly for their integration. Jay Lemke (2004) argues that taking a literacy approach to Science teaching and learning goes to the heart of what Science is, while James Gee (2004) asserts that discourse in the sciences has functioned as a blueprint for academic discourse in general and so should be better understood.

The disconnection between Science education and literacy is also evident in current South African curriculum documents as well as in classroom practice (Mayaba et al, 2013). The most recent curriculum for South African school children, the Curriculum and Assessment Policy

[13] The matriculation examination, or Senior Certificate, is the mandated school-leaving examination for state schools in South Africa.

Statement (CAPS), designates Natural Science as a compulsory subject for all learners in the Senior Phase (Grade 7-9). The scope of this subject is set out in the CAPS document (Department of Basic Education, 2011b). Before describing the content of the subject, the document presents an introductory section with the following headings:

- introduction
- indigenous knowledge systems and natural sciences
- teaching natural sciences, organisation of the natural sciences curriculum
- allocation of teaching time
- specific aims
- process skills and
- resources

In the section on process skills, elaborated as 'cognitive and practical process skills that learners will be able to develop in Natural Sciences' (ibid. p.11), fifteen skills are elucidated. Despite many of these skills referring to receptive and productive language skills (eg. 'recording information', 'accessing and recalling information', 'communicating'), the section on process skills ends with a separate heading, 'Developing language skills: Reading and Writing' (ibid. p.12). Under this heading the importance of reading and writing particular genres and reading and writing for assessment purposes is highlighted. The inclusion of this separate section for language skills reveals particular ideological orientations towards language skills in the Natural Sciences: firstly, that 'language skills' are separable from 'process skills'; secondly, that the only (or most important) language skills are reading and writing, neglecting speaking, viewing, drawing and others; thirdly, that these language skills are discrete and not interdependent.

A meaning-making lens

Having sketched the research problem in terms of constraining language ideologies in policy and practice in South African schooling and impoverished notions of the role of language and literacy in Science, I now turn to the lens I have used to address this problem.

'Meaning-making' is a term used to describe human action in the fields of sociocultural theory and social semiotics. It has been taken up prolifically in education studies to refer to what people do in learning environments as they make sense of new content. Drawing upon the theoretical language of social semiotics, Kress, Jewitt, Ogborn and Tsatsarelis (2014) posit that in meaning-making:

> there is the constant transformation of existing signifier resources (and existing metaphors then become part of this signifier resource), and the constant making of new metaphors. The process is guided by the *interest* of the individual sign-maker, so that both the individual's perception of the social world and the expression of their affective state enter into the new sign as the expression of their interest. (Kress et al., 2014, p.7, italics in original)

Kress et al. offer some key tenets of meaning-making as it is employed in education and which align with the goals of my study. Firstly, it focuses on the perspective of the *learner* as sign-maker and places her at the centre of the analytic gaze. Secondly, through the use of the verb 'transformation' it positions the learner as *active* in the construction of meaning in a social context. Thirdly, it positions the learner within her 'social world' thereby construing meaning-making as a social endeavour. Fourthly, it enables the study of all *modes* of communication in the making of signs in multilingual communication. This is an aspect of multilingual communication which has been neglected (Kusters, Spotti, Swanick & Tapio, 2017). Fifthly, it encompasses a view of *identity* development in learning through the emphasis on 'interest'.

In conclusion, 'meaning-making' is an open term allowing a researcher to see what exists and work from the ground up without imposing pre-existing categories. In this way it aligns well with linguistic ethnography which will be elaborated on in Chapter 3.

Research goals

The goal of this study is to better understand the meaning-making practices and potentialities of bilingual youth in a constrained English-dominant post-colonial learning environment in order to:

- *Contribute to new applied linguistics theory* in the field of South African education, by honing newly developed concepts and taking up the challenges offered by three scholars in the field:
    - to contribute to what Canagarajah calls 'a taxonomy of translanguaging' (Canagarajah, 2011) by excavating and describing the range of meaning-making practices of bilingual Science learners;
    - to extend the concept of translanguaging by employing both a multilingual and multimodal lens when studying learners' semiotic repertoires in action (Kusters et al., 2017)
    - to consider the temporal aspect of meaning-making in learning as motivated by Mercer (2008) through a study of a whole topic of Science learning.

- *Contribute to the shifting of the conversation about language in education* in post-colonial contexts from debates about which named language should be used as the LoLT in schools towards:
    - the location of bilingual children's and teacher's practices within the range of meaning-making practices thereby reducing the exceptionalism of bilingual languaging; and
    - the identification of pedagogic strategies which help our learners fulfil their potential in multilingual classrooms.

- Provide a nuanced understanding of meaning-making *from a learner's perspective.*

- *Influence policy, pedagogy and assessment* in post-colonial schooling towards a more just, meaningful and exciting educational offering for our children through new insights on multilingual and multimodal learning.

The study

The focus on learners' meaning-making practices called for a case study design employing the tools of linguistic ethnography in order to study in depth a few bilingual learners with an African home language background, and the school language environment in which these

practices occur. Over the course of a year I identified and gained access to the school in which I conducted my fieldwork. Success High is a young, selective government high school in Khayelitsha, Cape Town. Prospective learners must write an entrance test in Mathematics, Science and English. It was started as a Mathematics and Science intervention to improve the uptake of these subjects in Khayelitsha high schools. In 1999 a programme was being run within a teachers' training college for matriculants to redo Mathematics and Science in one year post-matric in order to prepare learners for university. When the programme's directors saw that Mathematics and Science intervention needed to happen earlier in the school career, they began offering Grade 10-12 curricula specialising in Mathematics and Science funded by WCED. In 2011 the programme moved to its own campus and became a fully-fledged state school. Grade 8 and 9 were included in 2011. Mathematics, Physical Science, Life Science and Computer Science are compulsory subjects. It is a no-fee school, but parents are asked to donate R400 (USD 32) per year. There is some external funding for one additional teacher and other resources.

In 2016 I joined the Grade 9B Natural Science class of Success High for the study of the topic 'Chemical Reactions'. I also made video-and audio-recordings of these lessons which formed the core of the interactional data of the study. I collected ethnographic data through interviews, questionnaires, fieldnotes and photographs. At the same time, I started a study group which I facilitated as an intervention component of the study.

Research questions

As the extent of the case came into focus before and during my research, my questions became tailored to the site. Therefore, the questions refer to the two sites within the school which are elaborated in Chapter 3.

How is Science meaning made through the multimodal discursive practices of a group of bilingual Grade 9 Natural Science learners during one topic of study?

1. What semiotic practices were observed in the classroom and study group?

2. How are these practices shaped by the language environment of the school and beyond?

3. What kinds of meanings (and their trajectories) are made as a result of these practices?

4. What are the implications of studying bilingual meaning-making with a semiotic repertoire lens?

Conclusion and thesis overview

This first chapter has served as conceptual and contextual background to this study. The rest of the thesis is set out as follows:

Chapter 2 provides a theoretical framing for the study as well as a literature review of the field of bilingual and multimodal classroom discourse.

Chapter 3 accounts for the methods I employed in the case study.

Chapter 4 begins the data analysis, focusing on the language environment of Success High.

Chapter 5 describes the first of the meaning-making categories I posit in the case: constrained meaning-making.

Chapter 6 describes the second category: guided meaning-making.

Chapter 7 describes the third category: spontaneous meaning-making.

Chapter 8 provides a conclusion, incorporating recommendations.

2 Theoretical framework and literature review

> *The continuous becoming of translanguaging opens up a space of limitless possibilities for speakers and learners, which promises a more just world.*
>
> - García & Li Wei, 2014, p.137

Introduction

To frame my study of bilingual learning in the particular context of Science education I undertook reading which brought two theoretical perspectives into view. I was more familiar with the first through my training in applied linguistics: a repertoire and resource view of language in the education of minoritised majorities. The second view coalesced from my more recent reading on language in Science education: social approaches to meaning-making in Science learning. These perspectives share common roots in Sociocultural Theory and Social Semiotics yet they offer different analytical foci which have been invaluable in my study. In this chapter I will discuss these two perspectives and how they have framed my study. I will follow this with a literature review of empirical studies that have investigated bilingual Science discourse of minoritised learners, particularly in South Africa.

Language as repertoire and resource

The first theoretical lens which frames my study is a particular view of language which has, to a lesser degree, been extended to other semiotic systems. This view has, amongst other uses, been applied to the study of children in educational contexts who come from culturally or linguistically marginalised groups. Scholars in the global North (cf. Creese & Blackledge, 2015; García & Leiva, 2014; Hornberger & Link, 2012; Jaspers, 2018) have used the term 'minoritised' to refer to the languages – and by extension their users – which have been positioned subordinately in the linguistic hierarchy in relation to their 'majority' counterparts. In Northern contexts these languages and their users usually comprise the minority in their societies. These are typically immigrants to countries such as Canada, the United States of America, the United Kingdom, Sweden, Denmark and Norway. In a post-colonial setting such

as South Africa, it is the indigenous languages and peoples who make up these minoritised groups. In the case of South Africa, these groups are numerically larger than the groups of descendants of the colonisers, hence the term 'minoritised majority' where the adjective refers to the power the group wields in society and the noun to its numerical size.

The view of language in the education of this minoritised majority which will be described below represents an ideological and epistemological shift in the conceptualisation of language in applied and sociolinguistics. It has been driven by bottom-up approaches to the theorizing of language. This means that the departure point for the study of language has been what speakers actually do with language, rather than a set of structures imagined to exist statically in individual speakers' minds. This has had an effect on the theorising of named languages, such as 'English', 'isiXhosa' and 'Mandarin'. Whereas a structuralist view of language and traditional linguistics has conceived of named languages as a linguistic fact, this shift recognises that named languages are socially and discursively constructed rather than being recognisable linguistic objects with a defined beginning and end. This insight into the social construction of languages has been taken up by scholars of African multilingualism who have pointed out that the naming, codifying and transliteration of African languages by missionaries and other colonial administrators amounts to the 'colonial invention' (Makoni, 1998; Makoni & Pennycook, 2005; Makalela, 2015) of discrete African languages. This is theorized as forming part of a political strategy of 'divide and rule', traces of which are seen in the nine separate official African languages enshrined in the constitution of democratic South Africa.

Acknowledging that the majority of the world's people are multilingual, scholars in these fields have driven a 'multilingual turn' (May, 2014) in the study of language in society, taking multilingualism as the norm and challenging the monolingual mindset of traditional linguistics, including linguistics which has studied multilinguals (Auer, 2007). Because the literature I will review has put this view of language to work to understand the power dynamics at play in language in education, a critical approach (Janks, 2010) and a social justice agenda (Piller, 2016) comes to the fore. Equally, a strong theme of this literature is the notion of language and literacy as social practice exemplified in new literacy studies (Street, 1984, 2014; New London Group, 1996).

The conceptual work of this first theoretical lens is divided below between 'what we have', semiotically-speaking, and 'what we do' with it.

What we have: linguistic and semiotic repertoires

The recent conceptualisation of language from the point of view of multilingual language use has much older roots. The insight that humans as meaning-makers draw on different linguistic features, voices and registers in their language use was consolidated through the work of Russian philologist Mikhail Bakhtin. As part of his theory of the centrifugal forces at work in language which tend towards decentralisation and diversity in utterances, his term 'heteroglossia' (Bakhtin, 1981, p.272) refers to the coexistence of different voices and registers and even named languages in texts. This, he argues, results in all language use being dialogic as the ensemble created by one language user is always understood in relation to other (co-present or absent) previous speech acts. In bilingual education studies scholars have been careful to point out that this simultaneity does not imply equality. In reality these different voices and registers are often in tension and are perceived by audiences differentially based on the particular power structures of the society in which they are heard (Ivanov, 2000; Bailey, 2007; Guzula et al, 2016). This relates to Bakhtin's theory of the centripetal forces of language which work to draw utterances in towards the central points of standardised, unitary language (Bakhtin, 1981, p.270). The notion of register as a way of categorising utterances with certain features in common has been well described in Systemic Functional Linguistics (Halliday, 1978) and it is a key concept in this study which will be more fully elucidated in a later section of this chapter.

Drawing on the concept of heteroglossia, sociolinguists have coined the term 'linguistic repertoire' (Blommaert and Backus, 2011; Busch, 2012) to refer to the totality of features which a speaker may draw upon in generating any text. 'Repertoire' is a term that has been in use since Gumperz and Hymes' 1972 foundational sociolinguistic work (cited in Blommaert and Backus, 2011). Blommaert and Backus (2011) describe linguistic repertoires as being shaped by use:

> Repertoires are the real 'language' we have and can deploy in social life: biographically assembled patchworks of functionally distributed communicative resources, constantly exhibiting variation and change. (Blommaert and Backus, 2011, p.23)

Blommaert and Backus point out that these features, or 'resources', making up our repertoires are diverse in origin and are deployed in different ways according to interlocutor and situation. Scholars of multimodality and multilingualism have extended the concept of repertoire to include modes other than the linguistic, arguing that a comprehensive description of meaning-making must take into account all modes and not privilege the linguistic (Kusters et al, 2017; Blackledge & Creese, 2017). Kusters et al (2017) use the term 'semiotic repertoire' to make this point. A repertoire approach to the study of the language use of bilinguals makes taking the object of study as named languages an impossibility. As Cummins (2008) has shown, the 'two solitudes assumption' in bilingual education where two named languages are taken to be existing in separate compartments in the mind and not interacting with each other does not hold up to empirical scrutiny and may be restrictive of bilingual learning.

Blommaert and Dong (2010) make the argument that the term 'resource' brings a necessary criticality to the study of language in society:

> Looking at issues of resources makes sure that any instance of language use would be deeply and fundamentally socially contextualised; connections between talk and social structure would be intrinsic. (Blommaert & Dong, 2010, p. 194, italics in original)

> In a critical study of language, the absence of certain discourse events and the particular shape of others because of matters of resource allocation should be a major preoccupation. (Ibid)

Considering semiotic features as resources has been taken up by scholars working on bi/multilingual education with a social justice imperative (Genishi & Dyson, 2009; Stein, 2000) in order to show the potential for meaning-making that children have. Originating in Economics, the metaphor of a resource helps to show that language abilities, like material

things, only become resources when value is placed upon them in the social world (Lo Bianco, 1996).

Embracing the terms 'repertoire' and 'resource' has implications for the naming and description of the people involved in any applied linguistic or linguistic ethnographic study. The dominant descriptor I have chosen for the learners who are the key participants of my study is 'bilingual'. Some scholars working in English-dominant post-colonial environments describe their students as 'English Second Language' (ESL) or 'English Additional Language' (EAL) learners. This reinforces the hegemony of English and identifies the learners according to resources they do not have rather than those they do have. Describing the resources that learners in these contexts have results in terms such as 'bilingual' and 'multilingual'. Terms such as 'emergent bilingual' (García & Li Wei, 2014) and 'balanced bilingual' (Cummins, 2008) describe learners as being at different points on a language learning trajectory, but fit better into a competence or language learning approach than a language-in-use approach with which this study is more aligned.

The term which I use predominantly in this study, captured by my title, is 'bilingual'. I use this term in hope, rather than, following García and Li Wei (2014), as a descriptor of a current educational reality. García and Li Wei use 'bilingual' in Northern contexts to describe 'specific educational efforts to develop children's plurilingual abilities or to use those abilities to educate' (Ibid., 2014, p.3). In South Africa, 'bilingual education' has traditionally referred to education for white children in English and Afrikaans, using a parallel- or dual-medium programme (Malherbe, 1946). While black children in the Bantu education system were taught through the medium of their home language until Grade 6 or even 8 before switching to English and Afrikaans, the current norm for African language speakers is to follow an early-exit model from home language LoLT in Grades 1 to 3, to English LoLT in Grade 4. Therefore, positioning the learners in my study as bilingual points to both their innate repertoires (including and superseding features of isiXhosa and English), but also to a hope that these will be recognised as resources in education. This choice of term is counter-hegemonic and its use has been met by bewilderment and resistance by various audiences on more than one occasion during the course of this study (see Chapter 3). South African audiences are used to thinking of bilingual children such as those in my study as either deficient English monolinguals (McKinney, 2017) or as African language monolinguals. Each incorrect

assumption leads to a different singular remedy for the language problems faced in our schooling system. The first leads to a call for more English and the second to a call for more of whichever standardised (or harmonised or invented) African language is deemed to be the 'home language' of the child. Both assumptions are based on strong language ideologies, which this study seeks to expose and critique.

Language ideologies[14] have been defined as:

> the sets of beliefs, values and cultural frames that continually circulate in society, informing the way in which language is conceptualised and represented as well as how it is used. (Makoe & McKinney, 2014, p.659)

The discussion of my choice of the term 'bilingual' above is illustrative of three key language ideologies in operation in South African schooling. First, the need to use a term which enumerates languages which people 'have' reveals an ideology of language as an autonomous object which can be counted. While I have argued for my strategic use of the term 'bilingual', by using the term I reinstate the language-as-autonomous-object ideology. I acknowledge that I am retaining parts of this ideology in the use of the term, but I argue that it is an important strategic move to accord my participants higher status. Second, a mindset which considers 'monolingualism, or a high level of proficiency in a single named language, (as) the norm' (McKinney, 2017, p.20) can be seen in operation. This monoglossic ideology is at work in the call for 'mother tongue education' or 'English-only' education for African language speaking children, ignoring the multilingual repertoires of these children which often do not match any version of 'mother tongue' given in policy. Third, an ideology which McKinney (2017) has called 'Anglonormativity' is at work in the use of the label 'English second language learners'. This ideology refers to 'the expectation that people will be and should be proficient in English, and are deficient, even deviant, if they are not' (McKinney, 2017, p.37).

This discussion of the terms I have taken up in this study to describe my participants and their language use has aimed to show how descriptive terms reveal my theoretical and ideological positions as do those in use which I contest.

[14] See also Woolard & Schieffelin (1994) and Gal & Woolard (2001)

What we do: translanguaging and trans-semiotising

Moving on from the notion of what we 'have' which the terms repertoire and resource draw attention to, I will now outline theories I employ which describe what people 'do' when they make meaning. The focus then shifts to language as social action. There now exists a plethora of verb descriptors which have been coined in recent sociolinguistic analysis to refer to language as action. The broadest term in use – languaging - originates in biology and has been taken up in psycholinguistics (Swain & Lapkin, 2013) and sociolinguistcs (Jørgensen et al., 2011). Languaging refers to the process by which humans make meaning using verbal language. Building on this term, scholars have coined terms[15] to point to the complexity of this process in multilingual meaning making.

In the field of bilingual education, the term 'translanguaging' has been widely taken up, and is currently being expanded to describe bilinguals' 'languaging-for-learning' (Guzula et al., 2016). It is a revitalisation of a term used by Welsh educationist Cen Williams in the 1970s (cited in García & Li Wei, 2014) to describe a pedagogy used in that bilingual context where texts would be read in one language and written about in another. Translanguaging has come to supersede the term 'code-switching'[16] which has been widely used in educational research. Translanguaging is used to describe a variety of practices in bilingual classrooms which challenges the assumption of traditional bilingual education programmes which try to maintain languages in silos, or one language at a time[17]. In fact, the variety of uses to which the term translanguaging is put has been criticised as a weakness of the term (Jaspers, 2017). I will argue, following Li Wei (2017), that translanguaging is useful as a 'practical theory of language' which is illuminating of the practices of multilinguals and 'monolinguals'[18].

[15] These concepts all reference this complexity in the combination of linguistic features and identity positions that multilinguals display in their language use. They include: 'polylanguaging' (Ag and Jørgensen, 2012), 'polylingual languaging' (Jørgensen, 2008) 'translanguaging' (Creese & Blackledge, 2010; Chimbutane, 2013; García & Li Wei, 2014; Guzula et al., 2016), 'metrolingualism' (Otsuji & Pennycook, 2010), 'plurilingualism' (Canagarajah, 2011), 'ubuntu translanguaging' (Makalela, 2015), 'crossing' (Rampton, 1995), 'code-meshing' (Canagarajah, 2011), 'translingual practices' (Canagarajah, 2013).

[16] For a review of code-switching in post-colonial contexts, see Ferguson (2003).

[17] For a South African example which points to the futility of trying to keep languages separate in a parallel medium setting, see Banda (2010).

[18] I use scare quotes around this term to indicate that the term monolingual is problematic as it operates within a language as countable object ideology.

Otheguy, García & Reid (2015) make the point that there should be no different analytical lens used when researching 'monolinguals' and bilinguals as all languagers employ apt grammatical features for the social situation they are in. The difference comes in the quantity of different grammatical features employed:

> The difference is that the idiolects of bilinguals contain more linguistic features and a more complex socio-cultural marking of which features to use when and where. (Otheguy et al., 2015, p.292)

If translanguaging can be used to describe practices of all languagers, it runs the risk of losing its explanatory power. When performing microethnographic analyses of interactional data, I sought narrower terms to do this explanatory work. I will draw upon the sub-types of translanguaging coined by Williams (cited in García & Li Wei, 2014, p.91): natural and official translanguaging. In an educational setting, natural translanguaging refers to spontaneous use of resources belonging to languages regarded as separate in order to accomplish learning; while official translanguaging refers to the planned use of more than one named language in activities and is usually set up by the teacher. García and Li Wei also point to different positionings of the practice of translanguaging in schools when they describe a learning space as either an *adaptive* or an *established* translanguaging space (García & Li Wei, 2014, p.133). In an adaptive space translanguaging practices occur but may not be sanctioned and are certainly not valorised or planned for. An established translanguaging space on the other hand, is set up to enable translanguaging and may even insist on it at times. These terms have been influential in my theory-building in response to the practices of the participants in my study.

While translanguaging and other terms described above have broadened our view of multilingualism, Kusters et al. (2017) have argued they still ignore the multimodal aspects of human action resulting in multilingual studies which ignore the multimodal and multimodal studies which ignore the multilingual. They argue as follows for the use of the term 'semiotic repertoires':

> We argue that the lens of semiotic repertoires enables synergies (between multilingual and multimodal research) to be identified and provides a holistic focus on action that is both multilingual and multimodal. (Kusters et al., 2017, p.1)

Recent exceptions to the normal multilingual research which Kusters et al. criticise, are the paper 'Translanguaging and the body' (Blackledge & Creese, 2017) which includes a thorough analysis of the multimodal communication of multilinguals in a United Kingdom market setting; a special issue of the journal Linguistics and Education which presents papers demonstrating children's multimodal and multilingual collaborations in learning (Kyratzis & Johnson, 2017) and the work of Angel Lin (2015, 2016) in Hong Kong. In the field of bilingual education, Lin has provided further terms which help me apply a semiotic repertoire lens to the learning environments in my study. Firstly, she proposes 'trans-semiotising' as a term which goes beyond translanguaging (Lin & Wu, 2014; Lin, 2015; He et al., 2016):

> The proposal of trans-semiotising as a communicative strategy broadens our horizon about bi/multilingual communication, since languages (as a central semiotic) not only interact with each other but also intertwine with other semiotics (e.g., visual images, gestures, sound and music) in human communication practices during which the common semiotic repertoire expands under the contributions of communicators. (He et al., 2016, p.5)

Drawing on Williams' descriptions of natural and official translanguaging (cited in García & Li Wei, 2014), I am able to describe two kinds of trans-semiotising in my study: natural and official trans-semiotising, using the same definition that Williams offered, but broadening my view to include strategic movement between different modes, such as drawing and written verbal expression.

The same critique as that which has been applied to translanguaging applies to trans-semiotising: using the prefix 'trans' still indexes movement across modes and/or named languages, a place 'from' and a place 'to' which we move which implies two separate entities. This prefix keeps us stuck in the language of separateness and boundedness which we are trying to avoid (Jaspers, 2017). A term offered by Lin which avoids this conundrum in multilingual education is 'expanded repertoire' (Lin, 2015). While referring to 'what we have', this term indexes a process of expansion which offers an egalitarian and growth-focused vision of using and mastering multiple resources in bilingual learning contexts. This is an

important departure from the view too often expressed in South Africa which has the goal of learning being the development of written academic English only.

Having reviewed my theoretical position on language and languaging, I now turn to a discussion of the approaches to understanding the role of language and other semiotics in learning Science. This constitutes a largely discrete set of literature.

Social approaches to Science[19] learning

In Chapter 1 I introduced 'meaning-making' as my over-arching theoretical lens for the study. Meaning-making is a prominent lens in social approaches to Science learning which straddle Science Education, Applied Linguistics and Semiotics. The history of this scholarship and its foci will be outlined below.

Sociocultural theory and social semiotics

In social perspectives on human meaning-making activities, two intertwined theoretical strands can be traced: Sociocultural Theory and Social Semiotics. Sociocultural theory is rooted in Sociology, Psychology, Philosophy and Anthropology and epitomised by the work of metatheorists such as Lev Vygotsky and Mikhail Bakhtin[20]. Two of the core concepts of meaning-making in this theory are that meaning is made dialogically between interlocutors and that the context is integral to making sense of the text. This view is in opposition to a mentalist notion of meaning-making which holds that meaning-making occurs within the mind of the individual (Lemke, 1990).

Social semiotics is the younger of the two theoretical strands and is drawn upon in the disciplines of Semiotics, Systemic Functional Linguistics (SFL), Sociolinguistics and Applied Linguistics. The development of the term social semiotics is attributed to Michael Halliday (1978) and concepts have been further developed by scholars such as Gee (2004), Kress et al (2014), Lemke (1990, 1998), Martin (2010), Christie (1995, 2005) and Gibbons (2006).

[19] The word 'science' has been capitalised when it refers to an academic subject or field.

[20] The work of these two theorists has been helpfully brought into conversation by Wertsch (1985).

Both sociocultural theory and social semiotics have been widely applied in the study of learning and teaching. Below I discuss some of the common tenets of these theories as they relate to this field.

Language and learning as situated social practice

The idea of language and learning as situated social practice epitomised by the field of new literacy studies focuses on literacy as context-dependent and not autonomous (Street, 1984; 2014). Further, literacy is not construed as a universal set of skills but rather a multiplicity of skills varying according to location, situation and activity. Some implications for the study of literacy practices follow:

- literacy is seen as part of the cultural practices of particular groups of people;
- literacy-learning is viewed as a social rather than solitary pursuit determined by the needs of a particular community;
- and literacy is viewed as comprising multiple competencies, sometimes expressed in the plural as 'literacies'.

A practice view of Science learning has influenced a substantial field of study of 'scientific literacy' which argues that learning Science should consist of developing scientific literacy in the broadest sense, being able to read, write, draw and do Science. Sociocultural theory also gives us the idea that meaning is jointly constructed in the social world (Vygotsky, 1978) through discourse. This insight has led to studies of dialogism in education, with scholars demonstrating how increasing the quality of classroom dialogue has significantly positive outcomes for student learning (Mercer, 1995; Lefstein & Snell, 2013; Alexander, 2008). The present study accepts that private meaning-making processes in the form of inner speech (Vygotsky, 1978) occur, but are beyond the scope of this study. However, traces of this private meaning-making are often expressed in different modes and time frames. A learner may express particular engagement through an alert body posture while reading a textbook, or traces of this reading may appear in argumentation later on in a topic of study.

Register

A key term in the study of language as social practice is 'register'. I draw upon the concept of register as it has been theorized in SFL and Linguistic Anthropology. The origin of the notion of register in social semiotics is attributed to Michael Halliday who defines register as 'the

clustering of semantic features according to situation type' (Halliday, 1978, p.68). Further, a variety of a language can be identified, and recognized, by certain syndromes or patterns of co-occurence among features at one or another linguistic level (Halliday & Martin, 1993). Halliday & Martin argue that registers:

> are best thought of as spaces within which the speakers and writers are moving; spaces that may be defined with varying depth of focus, and whose boundaries are in any case permeable, hence constantly changing and evolving (Halliday & Martin, 1993, p. 87)

This dynamic view of the nature of register is also presented by the linguistic anthropologist, Asif Agha:

> A semiotic register is a repertoire of performable signs linked to stereotypic pragmatic effects by a sociohistorical process of enregisterment (Agha, 2007, p.80)

Agha's term 'enregisterment' captures the dynamism and evolution of registers as they are used in cultural action. He defines enregisterment as:

> processes and practices whereby performable signs become recognised (and re-grouped) as belonging to distinct, differentially valorized semiotic registers by a population (Agha, 2007, p.81).

Agha's centering of process, rather than substance, is echoed by Lemke and Lin who argue that it is possible to bring a 'process-based ontology' to the study of register (Lin, Wu and Lemke, forthcoming, p.13).

By pointing out that registers are 'differentially valorized', Agha emphasises the dimension of power inherent in a register. This dimension is also prominent in the SFL definition (Halliday & Martin, p.104). It is the action of power at work through linguistic ideologies present in the context of school Science that (re)produces registers for Science as bounded and static. In contrast, the data in this study will be analysed to reveal processes and practices which are akin to enregisterment, or the generations of new and meshed registers, as part of learning Science. When registers are named in this thesis, such as '"English-

isiXhosa" scientific discourse' (p. 203), it is in order to draw attention to the static notions of register which circulate in the research site and to temporarily stabilise registers for analytical purposes.

Register in SFL has three components: field, tenor and mode (Martin, 2010). Field refers to the topic or conceptual domain that is being communicated about, for example chemical reactions in school Science; tenor refers to the interpersonal relationship being expressed through the communication, for example a relationship of deference between a learner and a teacher; and mode refers to the form of the text which is being created in the communication, for example writing. In this study, I use the umbrella term 'register' more frequently than the sub-terms field, tenor and mode. Agha's term 'semiotic registers' (Agha, 2007) draws attention to the multimodal realisation of register.

Register is a particularly useful concept for my study in that it has had much uptake in studies of the language of Science. It also provides a functional approach for the analysis of semiotic variation in my data, and allows me to move away from the focus on named languages.

Similar to register is Gee's term 'social languages' (Gee, 2004) which he describes as:

> a way of using language to enact a particular socially situated identity and carry out a particular socially situated activity. (ibid., p.14)

In this definition Gee highlights two interrelated functions of social languages: identity performance and activity accomplishment. Gee regularly differentiates between 'lifeworld social language' (Gee, 2004, p.16) and 'academic social language' (Ibid, p.15) when writing about school-based literacy. Studying language and learning as situated social practice lends itself particularly well to ethnographies, in particular linguistic ethnography which will be described in more detail in Chapter 3.

Another typology which can be used to describe what people do with language in classrooms is Barnes' (1992) terms: exploratory and presentational talk. These terms, which deal only with the oral mode, describe meaning-making which has as its purpose 'working-on-understanding' (Barnes, 1992, p.123) (exploratory talk) and that which keeps an audience in mind and is concerned with correctness (presentational talk). Similarly, Jim Cummins (2008)

describes in binary terms the difference between basic interpersonal communication skills (BICS, later called conversational language) and cognitive academic language proficiency (CALP, later called academic language) in order to detail what is involved in learning the two language types for bilinguals. It is CALP which is most difficult for emergent bilinguals to master, Cummins argues, due to its technical nature, lexical density and demands as a written register.

The concepts of register, social languages, exploratory and presentational kinds of talk and Cummins' language proficiency types are all typologies which can reinscribe separate, hermetically-sealed language categories, such as those summarised in Table 2.1.

Table 2.1: Register binaries

Types more aligned with learners' lifeworlds	**Types more aligned with the academic world**	**Theorist**
Exploratory talk	Presentational talk	Barnes
Lifeworld social languages	Academic social languages	Gee
Everyday registers	Scientific registers	From Halliday
BICS	CALP	Cummins
Primary discourses	Secondary discourses	Gee
Colloquial registers	Technical registers	Lemke
Spoken-like	Written-like	Gibbons

The binaries which the table above sets out have not been created by the theorists, but rather are brought into existence when they come to be used as analytical tools. The analysis in this thesis will problematise these simple binaries as analytical categories which, while helpful as a starting point to draw attention to the nature of language variation for different purposes, obscure the complexity of meaning-making in learning Science. Most well-known is the binary of 'everyday register' and 'scientific register' which are pitted against each other in descriptions of language in Science learning. Pauline Gibbons' (2006) work on the mode-continuum and 'register-meshing' has been foundational in my understanding of how language for Science works and my critique of the notion of register as it is sometimes used

in studies of Science language. She holds that teachers and learners fuse features of different registers together into a hybrid register. Furthermore, the idea of a meshed register allows the researcher to move away from registers existing in silos. This critique mirrors the 'multilingual turn' (May, 2014) in applied and sociolinguistics in which a key task has been dismantling the idea of named languages as discrete objects and revealing them for the social constructions they are. What will become evident is that I name registers very tentatively (using scare quotes, as in the heading below) and loosely, as, like named languages, named registers are a social construct, not a linguistic fact.

'Science registers'

Scholarship on 'the language of Science' in the West has a long history which is traced by Halliday and Martin (1993) from its origins in the sixteenth century when there existed a project to define a 'philosophical language' (p.5) to serve the needs of scientific research. Construing this language as a language for structuring knowledge, Halliday and Martin make the bold statement that 'the language of Science has become the language of literacy' (ibid. p.11). Certainly the history of these two 'languages' are intertwined, but perhaps more and more they are diverging as the purposes they serve diverge. For example, the language of literacy in school lags behind the innovations made in the social practices of literacy outside of school (such as those in use on social media). The language of the Natural Sciences has particular features in its lexicogrammar which have been identified by scholars such as Gee (2004) and Halliday and Martin (1993). Some of these features include technical vocabulary, a high degree of nominalisation and the use of the passive voice. The clustering of these features in (particularly) written Science language is what is known as the 'scientific register', and it is this register that students of Science need to master. However, this is not the only register which students use to *learn* Science. Lifeworld registers (Gee, 2004) are employed to grapple with concepts and 'work on understanding' (Barnes, 1992) and along the way to mastering the scientific register, students will use what Gibbons (2006) calls register-meshing (p. 131). This is the combination of lexical and grammatical features of what are considered separate registers into one utterance. Lemke (1990) emphasises the importance of this practice for learning Science:

> For most of their education in Science, most students will need to learn "bilingually" in both colloquial and scientific (language). (Lemke, 1990, p. 172)
>
> Students will begin to grasp semantic and conceptual relationships in colloquial language first. Then they will substitute scientific, technical terms for colloquial words. Only much later will they be able to speak "pure science". Along the way their version of scientific language will be an "interlanguage", a sort of hybrid of colloquial and technical registers. (Ibid., p. 173)

Lemke offers an extended metaphor here, likening the learning of the scientific register to the learning of a named language such as English. It is particularly apt in a literal bilingual context such as that of my research site where the number of distinct potential 'colloquial' and 'technical' registers multiplies. The use of scare quotes in "pure science" is important I believe in questioning the plausibility of the existence of a 'pure' register of science. Lemke relies on the discrete objects of 'colloquial registers' and 'scientific registers' to make his argument of hybridity for learning science. "Interlanguage" has also been critiqued as a linguistic term which displays monolingual bias, casting mixed language practices as deficient (Canagarajah, 2007; Ortega, 2014).

Learning as multimodal meaning-making

In Chapter 1 I argued for the use of the term 'meaning-making' in this study. Here I explore how it allows me to take a multimodal view of learning. Kress et al. (2014) have argued that 'meaning-making is learning from another perspective' (p.24). What needs to be learnt in any field, topic or discipline is described by Lemke as the 'semantic relations' between thematic (or meaning) units (Lemke, 1990). In this view, to make meaning, is to (re)construct the semantic relations in different ways (which includes different modes) over time. The usefulness of the term which is of relevance here is its indexing active and multimodal endeavour.

Studies of discourse in sociocultural theory and social semiotics focus variably on mode (Martin, 2010). Some scholars pay attention to the linguistic mode as paramount, while others (notably Kress et al., 2014; Block 2014) argue for multimodality as the only comprehensive explanation for social meaning-making. By choosing 'meaning-making' as a key object of investigation in my study, I align myself with a multimodal explanation of meaning-making

rather than those who study 'language practices'. However, due to the significance of language ideologies in my study and the dominant (even repressive) role of the linguistic mode in the high stakes activity of assessment in schooling, I pay more attention to linguistic data in my analyses of learning discourse in order to gain a clearer understanding of the impact of language ideologies and the discontinuities between learners' meaning-making in many modes and the constraints of the test. It is the imperative of a critical or social justice approach which gives me this emphasis on the linguistic data.

Learning (or meaning-making) as a multimodal endeavour has particular realisations in Science as Lemke explains:

> The language of science is a unique hybrid: It is natural language as linguists define it, extended by the meaning repertoire of mathematics (the set of possible meanings that can be made with mathematical symbols and the conventions for interpreting them), contextualized by visual representations of many sorts, and embedded in a language (or, more properly, a semiotic) of meaningful, specialized actions afforded by the technological environments in which science is done. (Lemke, 2004, p.33)

Lemke describes four different modes in this explanation: the linguistic, mathematical symbols, the visual and actions supported by physical tools. Similarly, in their study of rhetoric in the Science classroom, Kress et al (2014) analysed speech/writing, action and visual modes. Lemke, along with many others[21], argues that all learners' meaning-making modes should be incorporated in the learning journey. While this acknowledgement is important, scholars of multimodality have argued that a critical perspective is also important: the acknowledgement that while all modes have rich meaning-making potential, they are not all valued equally (Kress et al., 2014), especially in the constraints of standardised testing, where the monolingual written mode dominates.

Meaning-making as identity work

Both sociocultural theory and social semiotics focus on the identity work involved in learning. Kress et al. express how learning and identity construction are inseparable.

> The sign-maker remakes the resources of representation available, thereby remaking their potential for self-representation, and their conceptual, cognitive, affective 'inner' world. This, we believe, is the process which we describe as 'learning', though

[21] In South Africa the work of Arlene Archer, Denise Newfield and Pippa Stein has been influential.

> it is also the process whereby the individual constantly remakes her or himself. (Kress et al., 2014, p.7-8, italics mine)

Kress et al. point at two processes involved in learning: the re-making of signs and the re-making of oneself. These two processes are brought together in the Bakhtinian notion of appropriation in language use:

> The word in language is half someone else's. It becomes "one's own" only when the speaker populates it with his own intention, his own accent, when he appropriates the word, adapting it to his own semantic and expressive intention…not all words for just anyone submit equally easily to this appropriation, to this seizure and transformation into private property: many words stubbornly resist, others remain alien, sound foreign in the mouth of the one who appropriated them and who now speaks them; they cannot be assimilated into his context and fall out of it; it is as if they put themselves in quotation marks against the will of the speaker. Language is not a neutral medium that passes freely and easily into the private property of the speaker's intentions; it is populated – overpopulated – with the intentions of others. Expropriating it, forcing it to submit to one's own intentions and accents, is a difficult and complicated process. (Bakhtin, 1981, p.293-4)

The appropriation process which Bakhtin describes can be applied to the process of learning a new academic discourse. Bakhtin here uses the metaphor of struggle to describe the process ('seizure', 'forcing it to submit', 'difficult and complicated') in which language users make 'words', or Discourses (Gee, 2008), their own. Notions of the speaker's will, intentions and the metaphor of his/her private property saturate this passage. These notions index identity work which Gee (2004) argues is integral to learning a new academic discourse.

> Acquisition of a social language is heavily tied at the outset to identity issues. It is tied to the learner's willingness and trust to leave (for a time and place) the lifeworld and participate in another identity, one that, for anyone, represents a certain loss. (Gee, 2004, p.18)

Gee picks up Bakhtin's notion of an identity struggle involved in learning a new 'academic social language' (Gee, 2004) or register. But for Gee the struggle ends in defeat. In order to 'participate' in a new identity, a learner must 'leave' another identity. Following a number of scholars (Blommaert & de Fina, 2016; García & Li Wei, 2014; Norton, 2013; Rampton, 1995;

Makoe & McKinney, 2009; Makalela, 2014; and Lin, 2015) my view is that identity is fluid and multiple, and that foregrounding and backgrounding of identities happens in different situations. It is also important to note that registers are not simply carriers of particular identities. People may simultaneously index particular identities through using elements of a register in a particular mode while distancing themselves from that identity (Goffman, 1975) through a different mode. While I take up the notion of identity being fluid and multiple in this study, I also draw attention to the struggle inherent in negotiating one's identities, which the adjective 'fluid' fails to capture. For some the struggle is more intense than for others, as Gee describes:

> For some people, it (acquisition of a social language) represents a more significant loss in terms of a disassociation from, and even opposition to, their lifeworlds because their lifeworlds are not the type of middle-class ones that historically have built up a sense of shared interests and values with some academic specialist domains. (Gee, 2004, p.18)

In leaving the lifeworld way of speaking and entering into the scientific social language, the following are examples given by Gee of what is lost: concrete things, empathy, changes and transformations as dynamic, ongoing processes, telos and appreciation. The following could be gained: abstract ideas and relations among them; traits and the quantification and categorization of traits; and evaluation within a specialized domain. Gee then goes on to make an important point about the relation of these losses and gains to learners' identity which is worth quoting in full:

> The crucial question is, Why would someone – most especially a child in school – accept these losses? My view is that people will accept this loss only if they see the gain *as a gain*. So, a crucial question in science education ought to be, What would make someone see acquiring a scientific social language as a gain? … People can see a new social language as a gain only if they recognize and understand the sorts of socially situated identities and activities that use the social language, if they value these identities and activities or at least understand why they are valued, and if they believe they (will) have real access to these identities and activities or at least (will) have access to meaningful versions of them. (Gee, 2004, p. 17 italics in the original)

Scholars have documented examples of some more outspoken learners struggling to accept these losses. For example, Brown (2006) studied teenage Science learners in an urban

California school and reported on their alienation from the discourse of science captured in one student's cry, 'It isn't no slang that can be said about this stuff' (Brown, 2006, p.96). Of course, learners are often forced to accept the loss of their everyday registers in the Science classroom, through punishment of their use or through the reinforcement of test scores. But if these are the only conditions for learners accepting this loss then their use of the new scientific registers will most likely be limited to what Lemke calls 'fixed words' (1990, p.91), the rote learning of phrases with or without understanding them. Another factor limiting the use of the scientific registers to fixed wordings, is when the learner has not been exposed to enough of the new register or not taught strategies for moving from the old to the new register.

Gee's contention that learners need to see the gains of the scientific register as a gain raises the question: how do we know when learners are experiencing this gain? Where the identity shifts are less effortful scholars have found that learners and teachers express hybrid identities (Ballenger, 2010; Makoe & McKinney, 2009; Hanrahan 2010). I address hybrid identities in the study through attention to the multimodal ways in which learners express interest in learning environments. Interest is a concept taken up by Kress et al. (2014) who argue that learners' texts are expressions of their interest in the topic. I understand interest here to refer to those aspects of the thematic framework of the topic to which the learner pays attention. Trying to understand and unpack learners' interest in the topic of 'chemical reactions' was a key occupation of mine as the facilitator of the study group. In this I was influenced by the work of Roseberry, Warren and Conant (1992), Cynthia Ballenger (2010), Lee and Fradd (1998) and Brown (2006) whose participants took an inquiry-based approach to teaching and learning Science.

Meaning trajectories

The process of teaching and learning in school has a natural long-term trajectory and cannot be understood only as a series of discrete educational events (Mercer, 2008, p.33). Indeed, this trajectory of learning extends beyond school as Barnes explains:

> Most learning does not happen suddenly: we do not one moment fail to understand something and then the next moment grasp it entirely... Most of our systems of ideas

> - call them schemes, frames, models, or concepts go through a history of development in our minds, some of them changing continually throughout our lives. (Barnes, 1992, p.123)

Based on this understanding, Neil Mercer in his 2008 paper 'Seeds of time' argues for a temporal analysis of classroom talk. He argues that:

> a temporal analysis can help us see how students' ideas change through the extended process of interaction with a teacher and other students, and how new concepts, ways of using language, and ways of solving problems are appropriated. (Mercer, 2008, p.56)

This change of ideas, he posits, is seen through a 'dialogic trajectory' within the discursive process of teaching and learning where meaning-making builds on previous conversations. While Mercer's focus is on teacher-student and student-student *dialogue* I believe that his argument for a consideration of the temporal dimension of meaning-making in learning can be extended to include all modes. Lemke's description of learning as 'a trajectory of meaningful action' (Lemke, 1998, p.4) moves in this direction as well as Iedema's notion of 'resemiotization' which is a dynamic view on semiosis and explains how a representation 'unfolds through time' (Iedema, 2003, p.49). I argue that paying attention to the full range of expressions given to the semantic relations (Lemke, 1990) of the topic at different points in time can yield valuable insights into learners understanding of the topic at that time.

Researchers of multilingual learning environments have paid attention to trajectories of discourse, especially the use of the first and second language along this trajectory. Setati & Adler (2000) posit different journeys that learners and teachers in South Africa can make on their way from their main language to English and from informal talk to formal writing. Lin (2015) proposes a journey towards an expanded repertoire where L1 and L2 language resources are used as bridges to meaning. Both of these models focus on named languages in use as salient features of the learning trajectories. What I propose is different in that the trajectory is focused on meaning, hence discourse is analysed for the progression and development of a semantic relation within the topic, rather than for identifiable named

language resources. I propose that *meaning trajectories* be studied based on interactional data, as I have done in Chapter 5.

Categories for analysis of Science learners' meaning-making

Scholars steeped in both sociocultural theory and social semiotics have studied the discourse of Science classrooms[22]. This forms part of a wider tradition of studies of classroom discourse beginning with the foundational work of Sinclair and Coulthard (1975) which proposed the quintessential classroom discourse structure of initiation-response-evaluation or IRE discourse. In the context of South Africa, a recent metastudy of research into Science and language has been conducted drawing together work in this area (Msimanga et al., 2017) as an attempt to define and draw attention to a small field.

Two of the foundational studies of Science classroom discourse have sought to construct comprehensive analytical categories of meaning-making practices in order to explain their discourse data drawing upon sociocultural theory and social semiotics. These studies were conducted by Lemke (1990) and Mortimer and Scott (2003). The studies were undertaken in 'monolingual' contexts: Lemke (1990) in English medium classrooms and Mortimer and Scott (2003) in one Brazilian Portuguese classroom and one English classroom. In reality of course, features of more than one named language or register were undoubtedly drawn upon in these sites. Indeed, the Brazilian research is reported on entirely in English and the fact that the spoken language data has been translated from Portuguese is mentioned for the first time in an appendix (Mortimer & Scott, 2003) thereby in effect obscuring the heteroglossia of the research itself. But pointing out that the studies took place in monolingual contexts is important in that they differ qualitatively from my research in which participants used features of two named languages much more regularly and in patterned ways. That being said, as foundational studies of meaning-making in Science classrooms, they informed the categories for analysis which eventually grew out of my data. Hence, I will outline their categories below.

[22] See Lemke (1990), Mortimer & Scott (2003), Kress et al (2014), Gibbons (2006), Gee (2004), Probyn (2015), Roth (2004).

Activity types and thematic development strategies

Jay Lemke posits two sets of categories to analyse classroom discourse in Science. The first set is activity type. He asserts that:

> The "unwritten rules" of classroom behaviour can be described in these two ways: by activity *structures* that tell us what sequences of actions are expected to happen in particular contexts, and by the *functions* that these patterns perform in the classroom. (Lemke, 1990, p.49, italics in original)

These 'structures' and 'functions' he draws together in what he claims is a comprehensive list of activity types of the Science classroom which form one set of organising categories for analysing his discourse data (Ibid., p.50). I argue that these categories are very useful for directing the analyst's gaze towards the purpose of classroom activities and the characteristic features of each. Lemke asserts that 'there is usually only one activity type going on in the classroom at any given time' (Lemke, 1990, p. 50). However, this assertion reveals a teacher-centred approach to the analysis of classroom discourse. From the teacher's perspective this may be true, but it neglects how activities can happen concurrently in the classroom which has a powerful effect on meaning-making. For example, during seatwork which Lemke defines as 'an activity in which students work independently at their seats on tasks specified by the teacher' (ibid., p.217) learners may be involved in a host of other activities of a social or academic nature which affect their learning powerfully. These 'activities' are labelled 'side-talk' by Lemke and not differentiated according to function and not included in the list of activity types. In this instance, Goffman's theory of dominant and subordinate channels of communication is instructive (Goffman, 1981). Goffman describes their mutual constitution as follows:

> Subordinate communication (is) manned, timed, and pitched to constitute a perceivedly limited interference to what might be called the "dominating communication" in its vicinity (Ibid. p.133).

Lemke's 'side-talk' therefore amounts to 'subordinate communication' which can have its own set of intentions and Science meanings. For the learner it is probable that the subordinate channel of communication – the conversation at her/his work table during

seatwork – is more significant than the written answers which s/he reads out to the teacher after the activity is complete. In Chapter 7 I offer examples from my data of these powerful activity types occurring in the subordinate channel of communication. The other way in which activity types function which my data illuminated and which is not discussed by Lemke is how activity types are often nested inside one another. This insight was gained during stage 2 of my data analysis (see Chapter 3) and helped me to see how classroom discourse is quintessentially a responsive and flexible endeavour.

The second set of categories which Lemke offers is thematic development strategies. He defines these as 'strategies by which teachers and students come to share a new thematic pattern in their classroom dialogue' (1990, p.100) and 'the specific techniques used by teachers and students to build up a network of semantic relations among the key terms of a subject' (ibid., p.225). These strategies have been a useful theory to help explain how bilingual learners draw on different resources to do the same conceptual work performed by these 'monolingual' strategies. For example, the equivalence strategy of glossing is when 'an expression is immediately followed by a close synonym, or a formal or informal definition' (ibid., p.226). This strategy is functionally the same whether the synonym or definition of the expression is offered using features of the same named language or a different one.

Focus, approach and action

Based on their research in Britain and Brazil of ten years' duration, Mortimer and Scott (2003) propose an 'analytical framework' to 'analys(e) and characteriz(e) the various ways in which the teacher acts to orchestrate the talk of Science lessons in order to support student learning' (p.24). We see here that the departure point is clearly the discourse of the teacher. The framework is expressed diagrammatically and reproduced below in Figure 2.1.

	ASPECT OF ANALYSIS	
FOCUS	1 Teaching purposes	2 Content
APPROACH	3 Communicative approach	
ACTION	4 Patterns of discourse	5 Teacher interventions

Figure 2.1: Mortimer and Scott's analytical framework

Aspects 4 and 5 have much in common with Lemke's activity types and thematic development strategies respectively. Aspects 1 and 2 go broader than Lemke in that they distinguish different teaching purposes and different kinds of content in the science topics both of which influence the communicative approach, patterns of discourse and teacher interventions. This is important for my study which was focused on one small topic of chemistry in the Natural Science curriculum. This content certainly affected the discourse data I collected and drew my attention to this.

The most influential part of the framework for my study has been the central aspect, the communicative approach (3). Mortimer and Scott delineate four classes of communicative approach on two dimensions or continua: dialogic-authoritative and interactive-non-interactive (p.33). These dimensions tease out the treatment of differing views on the content (authoritative or dialogic) from whether one or more people are involved in the interaction (interactive or non-interactive). This aspect of analysis has been influential to my own categories as it focuses attention on the learners as actors in the classroom – a key element in my study.

Constrained, guided and spontaneous meaning-making

Having sketched the analytical categories which were used in the three studies above, I now introduce my own categories which emerged from my data: *constrained, guided* and *spontaneous meaning-making*. They are used to organise the analysis and constitute a theoretical contribution to the field. I propose that these categories could be productively put to use in analysing meaning-making in Science (or indeed any subject) learning in any educational context, but are particularly helpful in a post-colonial bilingual context using a semiotic repertoire lens. I posit that these categories, in contrast to those above, centre the analysis on the learners' perspective, particularly on issues of identity performance and development. They also privilege a holistic view on learners' meaning-making which facilitates multimodal discourse analysis.

Constrained meaning-making is that semiotic activity in which learners submit to the authority of the teacher or other text in terms of topic and register choice. Knowledge is narrowly defined according to the interest of the authority external to the learner and the parts of the semiotic repertoire of the learner which are engaged are defined by this external

authority. Activities are prescribed by the teacher and there is little freedom for the learner in carrying these out. An example of constrained meaning-making is found during 'tight' IRE sequences led by the teacher in the plenary of a classroom.

Guided meaning-making takes place in activities set up by the teacher which allow learners to draw on a wider part of their semiotic repertoires as they engage in the topic. Teachers may prescribe particular registers and genres for learners. Learners have some freedom in co-designing the activities according to their own interests, within limits. An example of guided meaning-making is found in an open-ended writing task where learners have some autonomy over the resources they use to complete it.

Spontaneous meaning-making is that type of meaning-making in which learners engage with no intervention, provocation or directed stimulus provided by the teacher or facilitator. Instead they generate meaning spontaneously, drawing on whichever semiotic resource is available and best expresses their interest. An example of spontaneous meaning-making occurs when a learner asks an unsolicited question during an exposition of new content by the teacher.

Literature review of empirical studies of bilingual and multimodal classroom discourse focusing on Science

This final section of the chapter provides a literature review of studies of classroom discourse in minoritised language contexts. I begin with studies beyond the borders of South Africa before reviewing South African studies.

International bilingual Science studies

The international literature pertaining to bilingual Science learning is extensive. Here I focus on those studies which supply data extracts from Science classrooms, taking the Science content as central.

While not engaging with bilingual discourse per se, Pauline Gibbons' work with multilingual learners in Australia is important as it is the most comprehensive study of language use in the

topic of Science in a bilingual environment. Her 2006 study followed two teachers and their 9-10 year-old learners through a unit of Science in English which she had had a hand in constructing. She worked with the two teachers to design a unit with a particular focus on developing language along the 'mode continuum' from everyday spoken language to scientific written language. Her thorough study drew on analysis using SFL to highlight the value of exploratory talk, metalinguistic awareness and teacher-guided reporting in the learning process. Gibbons emphasised the role of a language aware teacher in scaffolding through talk and using a meshed register as a bridge to the more formal scientific register in which the learners need to learn how to write.

In Hong Kong the work of Angel Lin (2007, 2015, 2016, Lin & Wu, 2014) has pushed innovations in understanding multilingualism in Science education. She has broadened her analysis of multilingual classroom talk to include other semiotic modes with her term 'trans-semiotizing' (Lin, 2015).

In North America scholars have focused on pedagogies which benefit minority groups such as African-Americans (Brown, 2006) as well as studies with bilingual English/Spanish speakers (Hanrahan, 1999; Rosebery et al, 1992; Langman, 2014; Mazak & Herbas-Donoso, 2014) and speakers of Haitian creole (Ballenger, 2010). A key finding in these studies has been that the combination of expanding the use of different linguistic resources along with inquiry-based learning has been particularly productive. Poza (2018) linked full use of bilingual repertoires, extensive collaboration, and authentic experience and exposure to target language varieties as factors supporting the learning of new content and linguistic forms. Poza also emphasises the need for students to master the scientific register in English because of its use in high-stakes assessments:

> I argue that translanguaging practices support students in their development of scientific content knowledge and skills, but that if translanguaging perspectives are to become central in the design of bilingual programs, attention must also be paid to student's authentic opportunities for input and modelling of target language practices insofar as these seem inexorable measures of achievement and learning in the current accountability landscape of US schools. (Poza, 2018, p.3)

Studies of bilingual learning across the globe necessarily have different foci given the language ideologies and societal circumstances of the study. In Sweden, urban schools are often multilingual with disparate languages and cultures being represented in one class and the teacher being monolingual Swedish. This linguistic make-up is very different to my study in which the learners and teacher share a home language. In a study by Ünsal et al. (2017), the authors analyse data from discussions among the students separately to those between a student and the teacher. In teacher-student discussions the authors identified two main types: Initiation-Response-Evaluation (IRE) and longer discussions. In IRE discourse learners' answers were short and dominated by the linguistic mode, however in the longer discussions students expressed their more complicated ideas by drawing on action modes and metaphor.

Outside of South Africa, the African work in bilingual Science learning which most closely corresponds to the South African milieu is that of Chimbutane in Mozambique. Chimbutane (2013) studied a mandated bilingual Changana/Portuguese programme and found a strong language separation ideology at play, despite translanguaging occurring in practice. Some primary school age learners colluded with the language separation rule in Portuguese Science lessons, while others flouted it. Chimbutane found that teachers had to model the use of Changana in Portuguese Science class otherwise the learners would not use it. In Rwanda, an intervention project was initiated which employed language supportive pedagogy and language supportive bilingual textbooks in English and Kinyarwanda in primary schools. Milligan, Clegg and Tikly (2016) found that the experimental textbooks were popular amongst teachers, learners and head teachers due to their accessibility and in all eight intervention schools there was a statistically significant advantage gained by the experimental group in comprehension tests. In Nigeria, Ayo Bamgbose (1983, 2000) reported on the Six Year Primary Project in which children who were part of an experimental group received tuition in their home language, Yoruba, for six years while the control group switched from Yoruba to English medium in Grade 4. Both English and Yoruba reading achievement increased in the experimental group. In Kenya, Grace Bunyi (1999) found that English medium education had a deleterious effect on educational outcomes and makes recommendations for introducing African languages into Kenyan education.

South African bilingual classroom discourse studies

South Africa's literature on bilingual classroom discourse from primary through secondary to tertiary contexts is relatively recent and reflects the conceptualisations of language in linguistics at the time. Early studies used the lens of code-switching to describe practices in English dominant schooling contexts. A prominent example is the study by Ralph Adendorff (1993) on teachers' code-switching practices from English to isiZulu. Adendorff found, similarly to Ferguson (2003), that teachers switched to the learners' home language for social as well as academic reasons. Chick (1996) added the insight that when English was used exclusively in a classroom of isiZulu-speaking learners the communication between teacher and learners amounted to 'safe-talk' which had as its goal saving face and performing the activity of teaching-and-learning, rather than the development of real conceptual understanding.

Studies since 2000 have paid particular attention to issues of language and power. Those working within a code-switching paradigm include Setati and Adler (2000), Setati et al (2002) and Muthivhi (2008). Others have taken up heteroglossic theories of language use to analyse classroom discourse, but as they do not relate specifically to Science, there is not space to review them here[23].

South Africa has a long history of bilingual Science teaching and learning in Afrikaans and English through the dual and parallel medium system (Malherbe, 1946[24]). However, there are no studies of classroom discourse in Afrikaans-English bilingual Science classrooms. This I believe is testament to the accepted nature of Afrikaans-English bilingualism in South Africa that these classrooms have not garnered interest from South African discourse analysts. After Adendorff's 1993 study which includes some Biology teaching data, Cleghorn and Rollnick (2002) present the first study focusing on multilingual discourse in the Science classroom.

[23] In primary and secondary classrooms see Kerfoot & Bello-Nonjengele (2014), Krause & Prinsloo (2016), Makalela (2014, 2015), Ramadiro (2017), Guzula et al (2016), Banda (2010), Makoe & McKinney (2009), Tyler (2016). In tertiary contexts see Madiba (2014), Paxton & Tyam (2010), Maseko (2014), Abdulatief & Guzula (2017). For multimodality in bilingual contexts see Stein (2008), Battacharya et al. (2012) and Archer (2000).

[24] Malherbe (1946) studied monolingual Afrikaans and English medium and different models of bilingual education to explore its consequences for academic achievement and social cohesion between the two linguistically-defined white populations in South Africa. His data included questionnaires for pupils and teachers and intelligence and scholastic tests for 18 773 school-going children. No classroom discourse data was included and indeed the functioning of bilinguals in these schools was not the focus of his study.

While the majority of their data extracts are presented already translated into English, they show how teachers and learners use code-switching from English into the African home language for a number of cognitive purposes such as metalinguistic awareness and deepening understanding. Probyn (2006) also draws on the concept of code-switching by Science teachers, but argues for the development of a 'coherent bilingual approach for teaching Science' (Probyn, 2006, p.391). Working on the Language of Instruction in Tanzania and South Africa (LOITASA) project in collaboration with colleagues in Tanzania and Sweden, Vuyokazi Nomlomo (2007, 2010) undertook a project in Cape Town studying English and isiXhosa Science teaching with an experimental design. In her study a control group was taught Grade 4 Science English and an experimental group was taught Science with LTSMs in isiXhosa. She found that there was a positive correlation between the use of the learners' most familiar language as a medium of instruction and learners' conceptual development, academic performance and self-esteem in Science. Indeed, the class of learners who were taught in isiXhosa performed better than those who were taught in English. These results were aligned with what Bamgbose found in Nigeria (Bamgbose, 2000). She also found that parents had positive attitudes to English and isiXhosa being used to study science. Like Cleghorn and Rollnick (2002), Msimanga and Lelliott (2014) found that Grade 10 learners spent over 90% of time in small group discussions talking about the Chemistry tasks. In contrast to the other studies reviewed in this section, they recorded learners' discussions with each other rather than focusing on the teacher's speech. They found that learners made and supported claims, challenged each other's ideas and questioned each other's thinking by drawing on their multilingual resources in these small group discussions.

Cleghorn and Rollnick (2002), Nomlomo (2007, 2010), and Msimanga and Lelliott (2014) all use the concept of code-switching with its concomitant languages-as-separate-units ideology to describe their data. Their studies also have strong advocacy agendas for the use of learners' home language in Science learning. When considering their data in the light of recent developments in applied linguistics theory, their participants' speech can also be described as natural translanguaging occurring in an adaptive translanguaging space (García & Li Wei, 2014).

Margaret Probyn (2006, 2009, 2015, 2016) has researched language in Science education from the perspective of enacted policy and classroom discourse analysis. Her 2015 study drew

upon multiple case studies in rural and township schools in the Eastern Cape. She found that the teacher who employed the most isiXhosa talk in her study used it for exploratory purposes and used English for presentational talk. In contrast to the three studies described above, Probyn (2015) represents a shift from the code-switching view of bilingual languaging to the use of 'pedagogical translanguaging' as a new descriptive category. In using this term, Probyn draws attention to the 'systematic and purposeful' use of both English and isiXhosa, which aligns with Williams' use of 'official translanguaging' in García and Li Wei (2014).

The studies I have described in bilingual Science classrooms in South Africa vary in focus from whole class teaching to learners' working in small groups. They also frame the practices they describe with different views of the mechanics of bilinguals' language use. The gap in these studies has been identified by Kusters et al. (2017). The studies have focused mainly or exclusively on the linguistic mode in bilingual classrooms and ignored other modes of meaning-making. My study seeks to widen the view on bilingual meaning-making in Science to include all modes, or to study, as Lin terms it 'trans-semiotising' (2015). In addition, the intervention component of my study sought to explore official trans-semiotising as a pedagogical tool, reported on in Chapter 6.

Conclusion

In this chapter I have sketched research trajectories in applied linguistic studies of multilinguals' language use and in studies of Science learning. From this work I have selected and expanded on theoretical constructs in order to address my research goals. The key concepts I have discussed are:

- Meaning-making: the multimodal engagement that a social individual undertakes to develop understanding. I have proposed three kinds of meaning-making in my study: constrained, guided and spontaneous meaning-making.
- Semiotic repertoires: these comprise signs in different modes which meaning-makers use to construct meaning
- Meaning trajectories: the path of meaning made through a topic of study
- Translanguaging and trans-semiotizing: moving between languages and modes previously considered to be separate and autonomous to make meaning

- Language ideologies: beliefs and attitudes about language that circulate in different contexts and work to constrain or enable language use

I have also provided a review of studies, both international and South African, of language and other semiotics in bilingual Science classroom discourse.

Chapter 3 follows, comprising a description of my research methods.

3 Methods

Social reality resists the charms of methodology.

- Abbott, 2004, p.4

Introduction

This chapter provides an account of the decisions I made in the construction, development and finalisation of the case study. In the sections which follow, I will address: study design and data collection; the complex identity make-up of a participant-observer and my data analysis methods. Issues of validity, reliability, generalisation and ethical considerations are addressed as they become relevant. Important framing concepts for my methods have been: issues in case study design; particularities of linguistic ethnography as an epistemological approach; and participant-observation as a collection of fluid researcher identities.

The sections which follow are not intended to be read as a chronological account of the progression of the study, but rather as peculiar important elements of methodology which gave the study coherence. There is a developing understanding that good social science research will necessarily involve acknowledging that its methodologies are fraught with complexities and are partial, exploratory and responsive to social reality in ways which often shake the pre-conceived research design to its core (Abbott, 2004; Copland & Creese, 2015). It is my aim in this chapter to be explicit about these tensions and my attempts to resolve them. This requires an alert, creative, ethically scrupulous and reflexive researcher. Evidence to support myself having developed these traits will be offered.

Design and data

The life of the question

'What am I studying?' is the first question that a researcher asks herself when planning a research project. This question might seem innocuous, but as I have learned, it is not so simple to articulate and questions emerge as the data pool becomes evident (Rock, 2015). I will

frame my answer to this question by working through three narrower questions: Which social problem is to be investigated? From which epistemological perspective is it to be investigated? Which instance of the problem will I study?

Which social problem is to be investigated?

I begin with the articulation and framing of *a social problem centering on language* which scholars in applied linguistics have agreed is a workable definition of the concerns of this field of study (Coffin, Lillis and O'Halloran, 2010). A social problem does not reveal itself to a researcher as a value-free, pre-existing object, but the researcher constructs the problem through her theoretical lenses which have themselves been influenced by life experience and academic training. In Chapter 1 I introduced aspects of my history which brought me to the point of investigating the problem of bilingual learners in a constrained content-learning environment. The field of South African schooling currently presents an array of language-related problems. A popular problem perspective can be articulated through the following question: 'What role does language have to play in the consistently high rate of failure for African-language speaking children in our English-dominant schooling system?' That African-language speaking children make up the majority of children in our schools and that the schooling system, as measured by the annual matric[25] pass rate, produces failure is uncontested (Probyn, 2016). Hence while it seems that this is a valid question, it assumes a deficit positioning of the children in question and affirms the hegemony of the national school assessment system as an objective and reasonable measure of children's innate and learned ability. Studies which seek to tackle this question will address the 'mismatch' between 'English second language learners' capabilities and the demands of the English curriculum, as well as the use of different languages by teachers using a 'code-switching' theoretical model. While these studies may be revealing of some of what is happening in classrooms, they conceal much of what learners actually do with language in learning and what they are capable of doing.

Beginning with the assumption that young people can and do use language (along with other semiotic resources) to make a variety of meanings both in and out of school, different

[25] Matric is the final year of schooling in South Africa. The matric pass rate refers to those achieving a basic level in all their academic subjects. Sometimes commentators refer to the number of 'bachelors' passes' which is an achievement level required for tertiary study.

language-related questions emerge related to children in South African schools. One such question is: 'How is meaning made by South African children drawing on their semiotic repertoire when they study particular content in school?' Questions such as this have been underexplored in South African research, as reviewed in Chapter 2. This question, with its concomitant theoretical assumptions, is what exercised my thinking in this study.

From which epistemological perspective is it to be investigated?

An exploratory approach to meaning-making practices such as that described above assumes a particular epistemological perspective. I have found this perspective to be best described by the emerging tradition of linguistic ethnography. The collection of methodological tools which comprise linguistic ethnography have been recently assembled, predominantly by scholars in the United Kingdom, to form a field of inquiry by that name. Following Coffin et al. (2010), I am careful here not to label linguistic ethnography as a methodology, but rather treat it as an epistemological perspective:

> By adopting an *ethnographic perspective*, we mean that it is possible to take a more focused approach (i.e. do less than a comprehensive ethnography) to study particular aspects of everyday life and cultural practice of a social group. (Green & Bloome, 1997, p. 183)

The notion of linguistic ethnography as an epistemological perspective is useful when the object of study is not the entirety of the everyday and cultural life of a group, but rather the practices of this group as they go about one particular social activity – in this case, learning Science in school.

Linguistic ethnography is a recently burgeoning field with well-established roots. In the United States, linguistics and ethnography have been married for some time in the discipline of linguistic anthropology. Metatheorists who have been drawn upon in linguistic anthropology are ethnographers Dell Hymes and John Gumperz (Copland & Creese, 2015). In the United Kingdom, anthropology has not provided a tradition of scholarship in pursuing of language, culture and society. Therefore, thinking in the community of applied linguists gathering at the annual meeting of BAAL (British Association of Applied Linguists) began to coalesce around analytical issues in studies of language in society where a fine-grained

analysis of interactional data was called for. The connection between attention to the details of in-the-moment interaction as well as broad societal issues of power and change is well summarised by Snell, Shaw and Copland (2015):

> Linguistic ethnography links the micro to the macro, the small to the large, the varied to the routine, the individual to the social, the creative to the constraining, and the historical to the present and to the future. (Snell et al, 2015, p.26)

Linguistic ethnography as a young tradition has been associated with scholars in the United Kingdom such as Ben Rampton, Angela Creese, Adrian Blackledge, Fiona Copland, Karin Tusting and Janet Maybin among others, and has been taken up in Europe, Australia and Africa. These scholars have recently provided summaries and critical reflections on the tradition in papers and books on methodology[26] but a review of this work is not undertaken here due to space constraints.

Classroom discourse is a field of enquiry ripe for the use of linguistic ethnography as there is already a strong tradition of classroom ethnography (Hammersley, 1990). In this tradition, we as linguistic ethnographers working in educational settings are much indebted to the careful ethnographic work of Courtney Cazden (1988) which serves as foundational in questions of theory and methodology.

Which instance of the problem will I study?

In order to achieve the kind of close analysis of interactional data that linguistic ethnography requires, I needed to investigate a particular instance of the problem I was interested in. The best way to study meaning-making practices according to linguistic ethnography is to study them in depth. Therefore, I required a small-scale case study (Blommaert & Dong Jie, 2010).

A much-asked question in case study research is: will the findings be generalisable? Yin (2009) argues that case studies are generalisable to theory, not to population. The theoretical work of case studies is also emphasised by Rampton who argues that:

> case studies seek generality by speaking more directly to existing theories and ideas, and they use their detailed analyses of particular circumstances to probe at the

[26] Rampton et al, 2004; Hammersley, 2007; Tusting & Maybin, 2007; Copland & Creese, 2015; Snell et al, 2015.

> general principles, processes and relationships that these theories and ideas normally see at work in the worlds they refer to. (Rampton, 2006, p.227)

This requires that case study researchers expend intellectual effort digesting and analysing the data which they collect before moving to make theoretical claims about it. This argument is also made about linguistic ethnography, where its 'empirical nature and bottom-up orientation to data, require working from evidence to theory' (Copland & Creese, 2015, p.26).

Finding and initiating the case

My search for a case began in 2015 as I wrote my proposal. I knew that in order to answer my research questions I would need to conduct an in-depth examination of meaning-making practices of a class-sized group of learners during a bounded phenomenon of one topic of study in one academic subject. This was because the discourse data I would collect would be voluminous and to conduct comprehensive microanalyses of all aspects of the different types of meaning-making would require all the resources I had available to me during my PhD study. My experience of school children and my reading in this field had also taught me that all young people are inventive and resourceful meaning-makers. As explained in Chapter 1, empirical evidence to show the inventiveness and resourcefulness of the meaning-making practices of the minoritised majority of black African-language learners in South African schools is sparse, as the research hasn't been conducted, but also schooling for these learners is highly constrained and so evidence of this resourcefulness is hard to come by. So, I would be looking for a particular topic, in a particular subject, in a particular type of school. I began my search by choosing the subject of Natural Science.

Discourse in the natural sciences has been described as the blueprint for academic discourse as expressed by leading scholars in the field of science and language:

> The language of science has become the language of literacy. (Halliday & Martin, 1993, p. 11)

> No domain represents academic sorts of language better than science. Science makes demands on students to use language – oral and printed – as well as other symbol systems that epitomize the types of representational systems and practices that students need to master for higher levels of school success. In addition, these

> languages and representational systems are at the heart of living in and thinking critically about modern societies. (Gee, 2004, p. 13)

Science also demands a variety of texts to be produced by learners in a variety of modes and genres. Learners may: conduct hands-on investigations; read, listen to, write and view explanatory definitions; make calculations using symbolic Mathematics as well as read and write other genres. For these reasons Science was a good choice for the study of a variety of meaning-making practices. This variety would mean that my findings may be relevant to meaning-making in other learning areas and subjects. Also, there exists a considerable body of literature of monolingual meaning-making practices in Science to which I could refer.

Natural Science topics are represented in the South African National Curriculum through the following subjects: Life Skills (Foundation Phase); Science and Technology (Intermediate Phase); Natural Science (Senior Phase); Physical Science and Life Science (FET Phase). I decided to focus my research on the Senior Phase level for two reasons:

1. The academic discourse in the register of the subject would be at an advanced enough level to necessitate considerable work in making meaning in this vastly different register from the everyday social registers of the learners.
2. The academic discourse in the register of the subject would not be too complex for a non-specialist (in Science) applied linguistics researcher such as myself to be able to cope with the content.

Schools with African-language speaking learners making up more than 90% of the learner body are in the majority in South Africa. The South African schooling system is highly segregated and this majority is largely schooled in peri-urban townships and rural areas. Living as I do in the suburbs of Cape Town, I had access to a number of township schools within driving distance from home. I knew I would need a context where bilingual learners would be interested and motivated enough by Science to be drawing on a wide range of their semiotic repertoires. I needed an able and motivated teaching staff who would be teaching on-topic for the extent of the study period. I hoped that the learners in this environment would display a range of semiotic practices. I also needed a research site which I could reach on a daily basis from home for a period of approximately one year. I needed access to this site and an

amicable working relationship with the school. Lastly, I needed a key participant in the form of a Natural Science teacher who would be willing to work with me.

It took me just under a year to get to the point where I had formed an agreement with the Principal of Success High to undertake the study in 2016. The school fulfilled my requirements for my study in that it:

- is 30 minutes' drive from my home
- has a selective intake and so guarantees intellectually strong learners with relatively high levels of both isiXhosa and English proficiency
- has a committed staff
- a Natural Science teacher who was willing to work with me
- a point of entry through an ex-colleague of mine who is on the school management team.

All Natural Science classes were taught by the same teacher and she agreed to participate in the study. This assent did not happen easily. There were reservations from her side. She was only in her second year of teaching at the time and was still building confidence. She suggested that I rather research the classroom of a more experienced teacher. However, due to my constraint of the limit of Senior Phase Natural Science, I did not pursue this option and rather sought ways of making the data collection less threatening for her. The primary way I did this was to adjust her consent form to eliminate the use of the data in anything beyond my own study and write-up. In many ways she was not an optimal choice as a participant. I perceived her rapport with the class to be weak and she resigned after two and a half years teaching at the school to take up a position teaching English in Asia. It was due to my nagging sense that she had assented to be a participant out of a feeling of obligation to me rather than her own willingness that I shifted my focus very strongly towards the meaning-making of the learners, rather than herself. Together we considered the six classes across Grade 8 and 9. Grade 9B became a sensible choice for timetabling reasons. While I perceived this class to be a co-operative and compliant group of learners during the data collection period, she became very frustrated with them towards the end. After one class lesson she confided to me that 'I don't have control over this class whatsoever' (C7). This mismatch between her perceptions and my own was awkward and I felt sorry for her and the learners that her

rapport with them was not better. I own that my identity as learner probably made it easier for me to identify with the learners than the teacher and having been a teacher myself, I was probably quite a critical participant in teaching which I perceived as largely transmission-style.

I began by gaining oral consent from the teacher (whom I shall call Ms B after her class, Grade 9B) to observe the first lesson. In the second lesson I handed out information letters and consent forms to Ms B and the learners (to be delivered to their parents) and described what I would be doing in more detail. When I had got to know the class a bit better I approached two learners who appeared open to working with me and relatively studious and asked them to wear audio microphones. The girl agreed immediately, but one boy refused before I asked another who agreed.

Hammersley and Atkinson discuss how, in gaining access to the desired data in ethnographic studies, the researcher needs to make choices about what information is given to whom about the study (Hammersley & Atkinson, 1995). These are quintessentially ethical issues. Issues of permission are important here, but also what needs to be taken into consideration is the effect that the information given to participants, whether they are directly or indirectly involved in the study, will have on their behaviour. There is a distinct element of having to sell one's project to participants, especially if they are busy teachers who could do without a researcher and her two video cameras in her classroom. To allay the teacher's fears, I emphasised the learners' language as my object of study rather than hers. The use of the cameras will be further discussed in the data section, but suffice to say here that their use caused some consternation. Another source of concern, particularly for the teacher was the presence of other adults in the classroom. On one occasion, I invited the two student-teachers I was supervising to accompany me to her lesson. I found out via the staff grapevine that she didn't like this at all. Student teachers observing classes is expected on teaching practice and a common practice in the school, but possibly the presence of three adults in her class was too much. On another occasion, the Principal gave permission for someone to take my place as videographer when I was ill, but the message didn't get to Ms B and she stated her displeasure at having a different person in the class, and so he left without video recording. Her relative inexperience undoubtedly added to her anxiety in this regard.

I learnt that one needs to strike the balance between giving clear and honest information and making one's project sound accessible, interesting, relevant and useful to the participants. Talking about the study can also present an opportunity for advocacy. One of the teachers at Success High asked me early on what my study was about. I answered by telling him that I was interested in how bilingual children learn Science. He retorted, 'How are our learners bilingual?' It had never occurred to him to label his learners in this way.

Extending the case through an intervention

Becoming part of Grade 9B early on in the year provided me with many advantages. I was able to build rapport with the teacher and the learners and also make the kinds of observations which Merriam states characterises the early stages of research:

> Researchers often begin a series of investigations by impressionistic, informal observation. (Merriam, 1991, p. 89)

One of the most important early observations I made in the class lessons was Ms B's extremely rare use of isiXhosa. I expected initial high levels of English use to be present in the bilingual classroom due to my presence as a white, English-speaking researcher – thus powerfully positioned in multiple ways in the classroom. However, as other researchers in South African bilingual classrooms have found, this monolingual use of English, considered 'best practice', usually falls away after the first few lessons with an observer present and the more usual practices of using features from different named languages settles in again (Probyn, 2015). This was not the case in this class as throughout the research project Ms B used English almost exclusively inside the classroom, whether speaking to the whole class or to individuals. This prompted me to consider an intervention element to the project. If I only collected data from the class lessons I would be limited in the arguments I could make about the bilingual learners' repertoires. I discussed my desire to offer some support to learners in a spirit of reciprocity with the Principal, and volunteered to run a Science study group for the learners in Grade 9B. It offered a different space to the classroom: less formal and lower stakes with no formal assessment. The study group, which took place during an existing study

period on a Tuesday and Thursday afternoon, functioned as both a learning space and a space for 'go-along' research[27].

I planned to lead a study group in which I would be facilitator and participant – leading the activities but learning alongside the children towards my goal of mastering the content of the Natural Science topic at hand. I advertised the study group during a lesson in which I asked for written consent from the learners to participate in my project. The learners then could indicate on their consent forms whether or not they would like to join the study group, either on a Tuesday or a Thursday.

The eight study group sessions consisted of some of those who indicated initial interest, plus others in the class and four learners from the other two Grade 9 classes who heard about the group. Attendance varied from session to session, with the smallest group comprising myself and two learners and the largest a total of ten people. I began planning the weekly sessions with the idea of repeating (and improving upon) the activities carried out in the Tuesday group on a Thursday. Attendance patterns did not make this possible beyond the first week and so I planned each session as a stand-alone. I expected different kinds of languaging and I planned to create an established translanguaging space (García & Li Wei, 2014) by inserting different kinds of languaging: both productive (eg. exploratory writing in isiXhosa) and receptive (eg. screening a Youtube video). The most regular attender at the study groups was Khethiwe. She was regularly the top-performing learner in Grade 9B Natural Science. She was an engaged and proactive member of the group. She also freely shared her feelings about the activities we undertook and therefore is a key participant in my study.

As the group was intended to support and extend the curriculum being followed in the classroom, I focused on following the interests of the learners, even when these diverged from the topic at hand. The pursuing of learner interest was easier at the beginning of the topic, but as the test drew nearer our attention focused on responses to test questions – an indication of the long reach of formal assessments. This meant that there was a greater diversity of activities at the beginning of the block than at the end.

[27] A mix of interviewing and ethnographic in-situ observation which is discussed later in the chapter.

I negotiated the use of a table in the school library as the venue for the study group meetings. We sat around the table in a group, surrounded by bookshelves. The learners left their school bags outside the library and entered with stationery and sometimes a textbook and notebook. I purchased nature study exercise books for each learner (with one blank and one foolscap page per leaf) which were used to varying degrees. Sitting on the same level, in close proximity to one another, created a convivial and egalitarian space. This assisted me in positioning the young people as legitimate learners and knowers (McKinney, 2017). The gap between the learners and myself was highlighted at times by the guileless teenagers. When I gave the example of the element gold by showing the learners my wedding ring, Asanda retorted: 'We don't have gold here, miss' (SG7).

Most activities were organised and initiated by me as teacher-learner, but unlike their regular class, some were initiated by the learners. I took seriously the exhortation by Reinsmith (1993) that in order for real learning to occur 'time must be wasted, tangents pursued, and side-shoots followed' (Reinsmith, 1993 in Yager, 2004). I was intentionally trying to offer approaches to learning a Science topic that weren't offered in the classroom. Hence, the study group became a research intervention, a co-learning space and a traditional teaching space.

The role of the intervention in my research worried me at first. My initial research design did not plan for an intervention. However, I found the words of Burawoy comforting and challenging in this regard:

> In the view of reflexive science, intervention is not only an unavoidable part of social research but a virtue to be exploited. It is by mutual reaction that we discover the properties of the social order. Interventions create perturbations that are not noise to be expurgated but music to be appreciated, transmitting the hidden secrets of the participant's world. Institutions reveal much about themselves when under stress or in crisis, when they face the unexpected as well as the routine. Instead of the prohibition against reactivity, which can never be realized, reflexive science prescribes and takes advantage of intervention. (Burawoy, 1998, p.14)

I have come to concur with Burawoy that intervention is an 'unavoidable part of social research' and that this can be capitalised on. It is in this light that I consider the study group which I initiated and facilitated as an intervention in the lives of my participants, similar to my interviews, which revealed more about their meaning-making practices. Following Kell (2006)

who described her study as 'an ethnographic project with an intervention component', I located my intervention within the broader project in what Yin calls an 'embedded single-case design' (Yin, 2009). The embedded units were the different sites of the classroom and the study group within the learning context of the Grade 9s as a whole.

Circumscribing the case through a data set

A linguistic ethnographic case study is eclectic in its data selection as in anthropological ethnography (Copland & Creese, 2015). Hammersley and Atkinson explain the broad spectrum of ethnographic data:

> In its most characteristic form (ethnography) involves the ethnographer participating, overtly or covertly, in people's daily lives for an extended period of time, watching what happens, listening to what is said, asking questions – in fact, collecting whatever data are available to throw light on the issues that are the focus of the research. (Hammersley & Atkinson, 1995, p. 1)

This iterative quality of data collection in linguistic ethnography means the data set forming the case can only be specified retrospectively. I planned my data collection during the proposal stage, but the extent of the data inevitably increased once my fieldwork began. I had to work hard to keep the amount of data collected manageable. There was data just over the horizon of my project which tempted me, such as the discourse of Natural Science of learners in the home, but collecting this data was beyond the scope of the project. There was also data which I did collect such as an audio recording of a Natural Science lesson which took place on the school field before the pilot phase of the project. This data was intriguing in its multimodality as it involved the learners as empirical researchers and research participants running and recording their heart rates, but falling as it did outside of the bounds of my chosen topic of study, 'Chemical Reactions', I could not use it. There was also data which I wanted to collect, but couldn't because I had an unforeseen health crisis, and on one occasion the timetable changed unbeknownst to me and I missed a lesson.

The data which I collected is set out in the table below:

Table 3.1: Final data set

Category	Description
Documents	NS Senior Phase CAPS document
	School language policy
	School application form
	NS textbook
	Entrance tests
Fieldnotes – 9 months	
Interactional data: 10 classroom lessons	Recordings from 2 static video cameras
	Recordings from 3 lapel audio recorders (incl. teacher)
Interactional data: 8 study group meetings	Recordings from 1 static video camera
	Recordings from 1 table-top audio recorder
Interviews (3) and go-alongs	Principal, Ms B (2)
	Teacher and learner go-alongs
	NS teacher playback
Photographs	Written work (learners and myself)
	Boardwork
	Environmental text
Questionnaires	9B learners (written)
	Staff (written)
	Staff (oral)

Documents

I was fortunate to receive all the help I needed in accessing the documents I required relating to language policy. I learned to search beyond the language policy document to find data relating to language ideologies which shape language use at school. The Grade 8 entrance tests and the application form were also used as data to analyse language ideologies at the school. The Natural Science textbook became a key document as it became clear how central

it was as a classroom text. All these documents were easy to collect, either by photocopying or taking digital photographs of them, or in the case of the textbook, by purchasing my own copy.

Observations: fieldnotes and unrecorded observations

While I aimed to record all my observations through fieldnotes, this was clearly going to be impossible. I will comment on the use of written fieldnotes here, but am mindful of the many memories of 'being in the field' (Blommaert & Dong Jie, 2010) which will have undoubtedly influenced my analyses in the findings chapters. Hence, I consider my memories as a virtual data set, the extent of which cannot be measured.

My physical fieldnotes can be divided into two kinds: more open ethnographic observations (Copland & Creese, 2015) written at a slight distance from the social action; and more closed fieldnotes written while in the class lessons. I wrote my first fieldnote on 19th November 2015 after my first visit to Success High where I met with the Deputy Principal and a Physical Science teacher. My last fieldnote was written on 25th August 2016. The open observation fieldnotes recorded anything I thought could be of relevance to my study that I noticed while interacting with participants and walking around the school premises. These notes I found very difficult to write initially. I didn't know what would be relevant. I began analysing what I was seeing, rather than just recording observations and I neglected to record interactions which in hindsight I thought had been relevant. The quality of these notes follows a bell-shaped curve. At the height of my data collection the notes are richly reflective, but at the beginning and the end they are thin.

The closed type of fieldnote was written during the class lessons. I describe these as closed because I was observing particular things in that environment. During the study of the topic my analytical interest was strongly in how the lessons were divided into activity types, so I recorded in my fieldnotes when I perceived a shift in activity type. I was using two video cameras to capture the meaning-making practices of the participants, but these could not capture all the learners from every angle. So, to mitigate against this loss of potential data, I wrote things of visual significance in my fieldnotes. I was also anxious that I might miss some of the spoken discourse through poor sound quality and so I transcribed some interesting utterances as well.

As the topic progressed and my identity as Science learner became more established, I began to complete the seatwork activities alongside the other learners. I began doing this in a separate notebook, but switching between this and my fieldnote book became tiresome and so my Science answers and my fieldnotes became merged in my fieldnote book. This inevitably meant that I inscribed fewer of my observations, but this proved no great loss as the video and audio recording quality was good.

Interactional data

My close analysis of situated language in use depended upon the audio-visual interactional data (Copland & Creese, 2015) of the learners' 'situated language use' in the class lessons and study group meetings. It is this category of data which informs the majority of my findings and which I spent the most time analysing. The close analysis of interactional data is what positions my study most strongly within linguistic ethnography. This analytic disposition is described by Snell & Lefstein (2012):

> Linguistic ethnographers share a particular analytic disposition and that this involves a focus on data and close analysis of situated language in use (cited in Copland & Creese, 2015, p.29).

I gave significant thought to the collecting of visual and audio recordings of classroom discourse. Positioning the cameras and audio recorders was influenced by my goals of unobtrusiveness, comfort for the participants and achieving a quality recording. During the pilot stage, which consisted of two lessons, I placed one camera in the back-left corner of the classroom focused on the whiteboard, and one in the front right corner focused on the learners. The three audio recorders were worn in pouches around the necks of the teacher and two learners situated in different groups in the class. The first adaptation I made after the pilot stage was the positioning of the two learners' audio recorders. I needed to collect data on learner speech during the class lessons on the topic and I knew that any more than two data channels would overwhelm my transcription resources, so I approached two learners to wear these microphones. My criteria for selection were: their willingness to participate in this way, a balance of genders, their habitual classroom position and their interest in attending the study group. In consultation with the learners, I agreed on Nomsa (a girl) and Mthobeli (a boy). They began wearing the recorders from the first lesson of the pilot

in which they were seated in rows. What soon became apparent was that the pouches were not suitable for participants who were mostly seated as they knocked against the table causing sound interference. Also, the speech of these key participants' interlocutors was difficult to hear as the recorder was directed so closely to the mouth of the key participant. After the pilot, there came a fortuitous structural shift in the seating arrangements which afforded a shift in my data collection technique. The desks were re-arranged in groups rather than rows and this configuration remained for the rest of the topic of study. I made the adjustment of placing the recorder on the table-top in the middle of the group in which my key participants sat and the key participant morphed into key groups of participants: a group of four boys and a group of three girls. Due to transcription constraints, the group of girls fell away as a key group and I used their data only as a support or when there was something important to hear from their side of the classroom. The shift from individual key participants to a group represented a shift in empirical perspective. The oral meaning-making practices in class became viewed much more as co-constructed (Mercer, 1995) and rarely have I analysed an utterance by one learner in isolation.

The second adaptation came in my own positioning (physical and ideological) in the lessons. I began by standing behind the camera which was positioned at the back of the room or perching on a cupboard or desk watching the teacher and the learners at work. As the study group was set up and envisaged as a co-learning space, I saw the futility in attempting non-participant observation in the class. I began to shift my position from standing or perching to sitting at a desk and engaging with the materials of the lesson: a textbook and a notebook, like the other learners were doing. In some lessons I had a learner share a desk with me, resulting in some discussion together of the content, but usually I was on my own. This had the result of the back camera being necessarily static, but the overwhelming advantage was that I was communicating to the learners that I was identifying with them as learners and shifting from a non-participant to a participant-observer.

Asking deliberately: Interviews, go-alongs, playbacks and questionnaires

In order to glean biographical information as well as gain an emic[28] perspective on the research concerns (Copland & Creese, 2015, p. 29) I employed four techniques of asking participants for this information.

The first was an initial open-ended, semi-structured interview with the Principal of Success High and one with Ms B. The purpose of these interviews was to gain insight into their language biographies, their position at the school as well as their views about language use at school. Most of the data from these interviews informed my analysis in Chapter 4. As Yin describes, my interviewing technique was typical of a semi-structured interview in that a consistent line of inquiry was followed, but the stream of questions was fluid rather than rigid (Yin, 2009). My interview schedules can be found as Addenda 4,5 and 6.

The second kind of interview is a hybrid of an interview and participant observation. It is what Kusenbach (2003) dubbed a 'go-along'. A combination of an interview and observation, the go-along occurs as the researcher accompanies the participants in their everyday environment as they go about their activities:

> What makes the go-along technique unique is that ethnographers are able to observe their informants' spatial practices in situ while accessing their experiences and interpretations at the same time. (Kusenbach, 2003, p. 462)

I was able to employ the go-along with the Principal, Ms B and the learners of Grade 9B. After my initial semi-structured interview with the Principal, I employed the go-along technique in my conversations with her when she handed me a copy of the school language policy or when we met in the staffroom to make tea. Anything of interest from these conversations I recorded in my fieldnotes. The go-alongs with the teacher occurred at a closer proximity to events about which the interaction happened. After Natural Science lessons I would frequently chat with Ms B at her desk before leaving her to prepare for the next lesson. The context for reflection was close at hand with the teaching and learning having come to a close only seconds before. Her views were unguarded in these interactions as she was in close

[28] An emic perspective is typical of ethnographic research and consists of trying to understand the research context from the participants' perspective.

proximity to the experience. The go-alongs with the learners were equally meshed with the situation giving rise to the reflections. These occurred during study group meetings when we discussed the activities underway or what occurred in the Natural Science lesson earlier in the day.

Similar to the go-along is a technique which artificially places the participant into a natural situation through a recording. In my study this involved playing back video and audio recordings I had made in the class lessons. I used this technique once with key learner participants and once with Ms B. This technique constitutes member-checking (Stake, 1995) to provide a foil to the researcher's analysis of the interactional data. This technique was more successful with the teacher than the learners. I provided the teacher with a transcript of the part of the lesson which I wanted her input on. She greatly enjoyed being exposed to the presentation of linguistic data in the form of the transcript and provided help in fine-tuning my transcript. The playback also provided a good context for talking about issues beyond the immediate context of the recording, as well as allowing time for the participants to develop their own interpretations of natural situations at some critical distance from them.

The last technique for asking for information was a questionnaire. I designed a questionnaire for staff and one for the learners of Grade 9B which served a similar purpose to the semi-structured interviews of the Principal and Ms B ie. to collect language biographies and information on language attitudes. Some way into my administration of the staff questionnaires, I abandoned them because it proved too difficult to collect responses from staff. I then resorted to brief oral questionnaires just for the academic staff which provided enough information to give the language biographical and attitudinal data analysed in Chapter 4.

Photographs

I used photographs taken outside of the classroom much more extensively than I expected to. The digital camera on my cell phone was invaluable in capturing quickly and discretely the examples of environmental text and extracts from books that are analysed in Chapter 4. In the study of public language in print for an inquiry into the language environment of the school, I relied on analysis done in linguistic landscape studies (for example, Stroud & Mpendukana, 2009) for categories of analysis of these texts.

The multiple identities of a participant-observer

Case study scholars have highlighted the different roles that researchers play in their sites (cf. Stake, 1995; Merriam, 1991). When I wrote my proposal, I indicated that I would conduct non-participant observation. In hindsight this was a misguided data collection method in a linguistic ethnography (Copland & Creese, 2015). In any event, I soon abandoned it as my roles at the school expanded. Not only did I begin to recognise myself as a learner and a mentor to the teacher, but I embarked on the study group and was asked to supervise student teachers at the school by my university. These visible roles helped me to recognise the other more invisible roles I was playing too: those of advocate and community participant. I settled into the 'schizophrenic activity' (Merriam, 1991, p. 94) of participant observation in which 'one usually participates but not to the extent of becoming totally absorbed in the activity' and 'one (tries) to stay sufficiently detached to observe and analyse' (ibid.). The balance between participation and observation shifted at different times during my fieldwork when I experienced one or the other as predominant. During the class lessons, for example, I felt more like an 'observer as participant' and in the study group I felt like a 'participant as observer' (Junker, 1960, as cited in Merriam, 1991, p. 92).

In a classroom setting the advantage of participant observation is that you gain access to events or groups which would otherwise be inaccessible to a non-participant observer. Young people's unguardedness means that a classroom researcher is likely to be drawn in to the social fabric of the setting whether she wants to be or not. Conversely, non-participant observation also has distinct disadvantages. Young people soon lose patience with a detached adult. Teachers may feel threatened if the researcher's detachment is experienced as judgement of their ability. Accepting that participant observation was my only option, I needed to become critically aware of how I was a key participant in the research.

In the list which follows my identities are presented as clearly distinguishable and separate. I will discuss my identity work as a guest of the community, observer-interpreter, learner-teacher, student supervisor, mentor, advocate and interpreter during my fieldwork. But in fact, the stance of participant-observer is present in each of the roles and is the thread that holds them all together. As my roles expanded at the school, so each identity began to affect

the others. Because I became a teacher in the study group, the learners' interactions with me in the classroom changed and they began to ask me for more help with their classwork.

Identities which came to the fore outside of the research site also influenced the research. During my fieldwork I was mother, sister, friend, daughter, consumer, sportswoman, employee etc. Some of these identities, such as advocate and employee, spanned the 'fieldwork' and 'other' sites in my life quite seamlessly; others, such as 'mother' I transported from 'other' to 'fieldwork' intentionally in my interactions; others such as 'friend' remain firmly in place in 'other' sites. I found the transition between 'fieldwork' and 'other' sites jarring at times and sought to ameliorate this by marking the transition in some practical way. I found satisfaction in the affordances of radio. When I was driving towards a site in my car, I would play the radio station which I associated with that site. So, when driving from the Southern suburbs of Cape Town to Khayelitsha in the morning, I would listen to Umhlobo Wenene an isiXhosa language station which is popular in Khayelitsha. This also facilitated my isiXhosa language learning and I would ask people at the school to help me understand what I had heard. When returning home in the afternoon, I would listen to Cape Talk, an English language station popular with the middle classes of the suburbs. As I was often tired in the afternoons, this also functioned as 'easy listening' as the language was familiar. In this way I would gear up for the respective site I was anticipating entering.

Linked to the identity transitions during my fieldwork is the flow of material things from one site to another. My recording equipment, field note journal, smartphone and teaching materials were key tools with which I entered the school. By the end of the day I had gathered and recorded data which I transported back home to store.

Guest of the community

As for all linguistic ethnographers, I needed to establish legitimacy in my research site. I needed to be seen as a community participant, although a transient one. I worked on this much in the same way all ethnographers do. I learned community members' names; I offered people cups of tea in the staffroom; I brought the Natural Science teacher the odd box of juice; I engaged in conversations on topics that teachers initiated; I brought the fruit-loving secretarial staff guavas from my tree at home; I arranged a farewell to the Grade 9B and Ms

B which included a gift and the screening of a video montage of my data set to music. In short, I came to care about the people at the school and I still do. There were two dramatic events during my fieldwork which affected me personally as well as my work: I had an operation which required me to be out of the research site for four weeks, and there was an armed robbery at the school which traumatised the school community - particularly Ms B who was closely affected.

Observer-interpreter

The role of observer-interpreter is the one which required me to be distant from the other participants in the study. This distance was increased by the extension of my observation through the recordings that I made - in particular, video recordings. Some participants found the cameras intrusive. After a few weeks, the Principal relayed to me that she had been approached by some of the learners in Grade 9B complaining that the behaviour of their classmates had changed for the worse because of the cameras – they were 'showing off'. This was obvious in the first few recorded lessons when learners posed in front of the cameras when they entered the class. The Principal addressed the class about the behaviour, but saw no cause for me to remove the cameras. I was concerned, however, and agreed with the teacher that she would check in with the class again in ten days' time about their feelings on the matter. This she did and the problem seemed to have diminished.

However, in discussing the experience of being involved in research with the study group at our last meeting, their comments on the cameras were mixed. Some were positive – 'you have to behave in a good way' and some negative 'it was great miss having you, but not the cameras' (SG8). There were no comments on the audio recorders. These seemed to be considered as an object of play as on two occasions I noticed a learner pick up the recorder and hold it out to a peer like a microphone.

I accepted that my data would be subjected to an observer effect. This was most tangible in the shifts in reactions to language use in the classroom. During the first two lessons learners corrected each other when they addressed the teacher in isiXhosa, exhorting them to 'speak English' (fieldnotes, 270116). This injunction fell away soon after that and learners spoke in isiXhosa more regularly.

Learner-teacher

Taking on the identity of 'learner' was surprising and invigorating. Two of the subjects I engaged in learning which were preordained by my choice of topic were chemical reactions and isiXhosa. In and out of the research site I threw myself into the learning of these subjects and this identity had benefits for my research. Hammersley and Atkinson (1995) quote educational ethnographers Olesen and Whittaker's description of how, in order to provoke the least response in the class tutor, she '(became) a student' by participating in the listening and writing that the students did (Hammersley & Atkinson, 1995, p. 177). I experienced how the participation as a learner in the classroom lent validity to the teacher's activities, given my authority as an adult in the classroom. It also helped to reduce the potentially counter-productive knowledge hierarchy of me as a doctoral student in a higher position to the teacher as a teaching diploma graduate. I deferred to her authority publicly in class and privately in interviews. In my role as isiXhosa learner, I was able to defer to staff members' and student teachers' authority in this regard and retain a humble position as learner. In the data chapters, I will present data to show that as the facilitator of the study group I often took up the discursive position of 'teacher' and the learners supported this through their use of 'miss' as a term of address for me. This is unsurprising in a school environment where ground rules of discourse with adults conventionally delimit formal terms of address. However, I also cultivated the position of 'learner' in the study group through explicitly discussing my own Natural Science learning process and adopting inclusive language such as 'we' when discussing learning challenges (see Chapter 6).

There were two occasions which were ethically challenging to me in balancing the role of learner and teacher. One occurred when, after a debate about the number of elements represented by the Periodic Table, I did some internet research and came to a different conclusion to Ms B but the same conclusion as some learners. I was torn between not wanting to undermine Ms B's authority to the learners and wanting them to have accurate Science knowledge. I resolved this dilemma by explaining my learning through the internet to Ms B before doing the same with the learners in my study group. The other occasion was a lesson in which learners were particularly frustrated by not being able to represent a chemical equation accurately. I shared their frustration and offered a solution which I inscribed on the

board, following other learners. My solution proved incorrect, which was helpful to me in confirming my partial grasp of the topic. However, there was potential damage to the authority of the teacher in becoming so involved in the dominant communication channel and over-stepping the remit of participant-observation.

Also, observing my own meaning-making in learning about chemical reactions helped me to identify with the learners who were my key participants and gain insight into the theory which I was attempting to build.

Education expert

The identity of education expert was developed through two key relationships during my fieldwork. The first was my relationship with Ms B. With my theoretical knowledge and experience of teaching I brought ideas about best practice and problem diagnosis with me to the class lessons. While I tried to background this identity, so as not to appear arrogant or critical with Ms B, there were occasions where my support was welcomed.

In a gesture of reciprocity and also hoping for an opportunity for more data collection, I offered to arrange a trip for the class to the Cape Town Science Centre. When Ms B explained that the Head of Science usually organised these trips, I did not pursue my suggestion. On one significant occasion I offered my analysis of a difficult lesson which Ms B was struggling with, diagnosing what I thought the source of the difficulty was. In the extract which follows, I am discussing the lesson with Ms B just after the learners have filed out of the classroom. Ms B has just confided in me that she feels like she has 'no control' over the class.

Extract 3.1: C7. No control

> Robyn: I mean Bongeka is struggling. She was struggling to understand but she didn't give up.
>
> Ms B: Ja.
>
> Robyn: She kept saying, you know (indistinct) I was quite impressed she didn't give up. I mean, for you it was hard because you wanted to move on.
>
> Ms B: Ja. And then I don't know what to say because... So that's why I just asked if they (indistinct)

Robyn: (Indistinct)

Ms B: Ja, Ja. It means they must understand it.

Robyn: (Indistinct) I don't know, and I don't think you don't have control. I think you do. I mean it's just that they're finding it very difficult.

Ms B: Really?

Robyn: Ja. I don't think…Do you know what? As I was looking around, every single one of them had a textbook open, they were going backwards and forwards to try and work it out.

The turn-taking is shared in the short extract and the exchange feels collegial. I also constructed the identity of education expert with the two student teachers whom I was supervising during their teaching practice period at the school. As they were expected to observe other teachers, I invited them to sit in on one of the Natural Science classes with me. They also became important as teachers of youth isiXhosa registers which enabled me to interpret my data more thoroughly.

Advocate

An identity which I was largely unaware of constructing during my fieldwork was that of advocate for multilingualism in education. Post-hoc, I find the label to be helpful in explaining much of my behaviour during my fieldwork. Interviews are particularly suited to advocacy. While it is the responsibility of an interviewer not to unduly influence the responses of the interviewee, she cannot but exercise influence through the questions asked and responses probed. Dornyei (2007) holds that 'some delicate balancing act is needed here between non-judgemental neutrality and empathetic understanding and approval' (Dornyei, 2007, p. 141). An interview is an advocacy tool in that it presents an opportunity for the interviewee to consider aspects of social reality previously unconsidered, or to consider them in a new light.

On two occasions the identity of advocate was particularly salient. The first was the go-along interview I had with the librarian captured in fieldnotes:

Extract 3.2: Fieldnotes 030216

> I teased her about there being so few Xhosa books and she said, yes, she realised the dearth after Mrs George left (who ran the library). She said she struggled to find good Xhosa books. Some she found (Fundza series), and the teen romances went 'flying out' of the library. The problem was that they didn't come back! (Isn't this a good reason for buying more?!)

My teasing of the librarian reveals my disapproval of the low number of isiXhosa books which would have been communicated in my teasing tone. Through this I was advocating for making the library a more multilingual space.

The second occasion was on first meeting Grade 9B and acquiring their consent to join their class as an observer. From the audio recording of that meeting, the following opening words have been transcribed:

Extract 3.3: Introductions 270116

> My name is Robyn. I am from UCT. Ndisafunda isiXhosa, so if niyafuna ukuthetha kum, I will really appreciate it. (My name is Robyn. I am from UCT. I am still learning isiXhosa, so if you want to speak with me, I will really appreciate it.)

Apart from foregrounding my learner identity, in my speech I am modelling translanguaging in a rather disruptive way. I am a white person speaking isiXhosa which is unusual, but also, I am mixing languages which in an educational setting usually holds a taboo due to monoglossic language ideologies.

And in the process of writing this dissertation I am an advocate of particular beliefs about language in education, trying to convince you, reader, of my views. This is a feature of case study research as described by Stake (2003):

> Discretely or not, they (case study researchers) do their level best to convince their readers that they too should believe what the researchers have come to believe. (Stake, 2003, p. 93)

Finally, the exposure of the participants in my study to academic and business registers in isiXhosa constituted advocacy. The consent letter to parents was translated into isiXhosa from English by a colleague of mine. This formal business register in isiXhosa provoked much interest in the learners. Thandile read the expression 'udliwano ndlebe' as a translation of 'interview'. He quickly made a literal translation of 'the eating of the ears' (C1) which he found highly amusing and consequently had the opportunity of learning a new expression. Equally the use of a scientific written register in isiXhosa during one study group provided the learners with exposure to a register which they had not encountered before.

Data analysis

As all scraps of information which help to answer the research questions become data for an ethnographer, so the analysis of this data begins the moment one sets foot in the research site, occurs constantly and is unending. While particular documents in files on my computer contain more reportable data analysis, there are other spaces – in emails, in supervision reports and in my 'future projects' folder – where analysis has occurred and has influenced my findings. This is not to say that the data analysis was not systematic. I will describe below three distinct stages which occurred throughout the project.

Stage 1: Transcripts and digitisation

The first stage of data analysis was to digitise my data for easier analysis. This involved the making of transcripts of discourse and the capturing of hand-written data into digital form (fieldnotes, learners' classwork and test scripts). I created folders on my computer for each day that I went to Success High. I transcribed fieldnotes from my notebook into Word files for each day. I labelled photographs of the environment of the school or learners' work and stored these in folders and transcribed them into spreadsheets for ease of comparison. I downloaded audio and video files nightly from the cameras and recorders and stored these in folders. Then I made transcripts from the audio and video recordings. These were made with the help of four bilingual isiXhosa-English transcribers over the course of the project. I worked with each to communicate the requirements of my analysis and demonstrate the conventions I preferred. The value of these working relationships cannot be overstated. Each

transcriber, but Babalwa Molate in particular, did important analytical work through making the transcripts. I also consulted Babalwa many times after she had completed the transcripts to listen to extracts with me and help me settle on a version. Fellow scholars in my department were also enlisted to help with this re-listening work. In total the five transcribers produced 18 transcripts of interactional data representing roughly an hour of discourse each. The transcripts were made predominantly from the video camera placed at the back of the classroom and the solitary camera in the study group as well as the audio recorder placed near one of the learners, Mthobeli, in the class lessons. The other recordings were used to check the transcriptions or to add details that the main recordings did not pick up. Three transcripts were made from the three audio recordings of the interviews which were conducted in English.

I will describe the structure of two levels of transcript which were created during my study. A first level transcript was broad, covered all the interactional data and assisted in drawing up codes for analysis. The second was more detailed and only utilised once extracts were selected for microethnographic analysis and for use in this dissertation. An example of a first level transcript appears as Extract 3.4.

Extract 3.4: SG1, Level 1, completed 100616 (for transcription conventions, see Addendum 1)

Time/Activity type	**Actor/Action**	**Speech**	**Gloss**
	Khethiwe	What's the question? What's the aim (indistinct)	
	Robyn	What is the question? What is the question?	
	Nandipha	What's the question?	
	Robyn	We want to know what are these made of?	

The first column served as a tracking device for me to identify parts of the transcript for analysis by *time* and *activity type*. Time was recorded in minutes and seconds as it related to the camera recording, with Mthobeli's audio time markers appearing in brackets. I recorded shifts in activity type (Lemke, 1990) in this column as well. These entries formed the beginning of Stage 2 coding. I consider the writing of the transcripts as part of the data analysis following Ochs (1979) who asserted that transcription is theory-making. For example, the column

headings I used to focus my own and other transcribers' attention displayed my theory of meaning-making as multimodal. I created a column entitled 'Actor/Action' drawing on multimodal discourse analysis (Iedema, 2003; Norris, 2016). Cognisant of a horizontal hierarchy of print which privileges text on the left, I placed action before speech in order to correct my natural inclination to view the verbal as most important. I also used the nomenclature 'speech' and 'gloss' to avoid naming languages and to enable the writing of different versions in the last column to assist my own and my audience's understanding where necessary. For example, an utterance (*speech*) in a variety which draws on features of English and isiXhosa is re-versioned (*glossed*) into standard English, not translated.

These first level transcripts along with the raw data were then used to identify moments for what Li Wei describes as 'moment analysis' (Li Wei, 2011) which:

> aims to capture what appears to be spur-of-the-moment actions that are semiotically highly significant to the actors and their subsequent actions, what prompted such actions and the consequences of such moments including the reactions by other people (2011, p. 1222)

The transcripts of these moments of high semiotic significance were then worked up into multimodal transcripts using the other video and audio recordings to increase the detail of the discourse. At this point further nuance was added to the spoken discourse in the form of indicators or tone, overlap etc. These transcripts were then subjected to microethnographic analyses in Stage 2 and some were selected for inclusion in this thesis.

Here is the same piece of data as Extract 3.4 transcribed as a Level 2 transcript:

Extract 3.5: SG1, Level 2, ongoing

Turn	**Actor/Action**	**Speech**	**Gloss**
1	Khethiwe Raises eyebrows when looking at Siphosethu	What's the question What's the **aim** //of the investigation	
2	Robyn	//What is the question What is the question	
3	Khethiwe	the **aim**	
4	Nandipha	What is the question	
5	Khethiwe	The **aim**	

6	Robyn Learners start to open books and prepare to write	We want to know what's what are these made of	

'Time/Activity type' gave way to 'Turn' as I prepared extracts during the write-up phase as I attended to the needs of an audience. 'Turn' does not always align with the conversation analysis definition as at times I include a back-channel or minimal response as a separate 'turn'. It merely serves the practical purpose of making it easier to refer to in the analysis. Next, I present the transcription of the action during the turn, including the name of the actor, again privileging the actional over the linguistic mode.

This Level 2 transcript can be described as the beginnings of a microethnographic analysis (Bloome et al, 2005; Kramsch & Whiteside, 2008; Zuengler & Mori, 2002; Erikson, 1996; Martin-Jones, 1995). This kind of analysis is a feature of linguistic ethnography and indexes the narrowed and focused nature which sets linguistic ethnography apart from a general ethnography. During microethnographic analysis more turns have been identified and actions modes added. This level 2 transcript is never complete as details may be added during further analysis for different purposes. Indeed, the interactional data that is used in the findings chapters does not conform to a set transcription structure, but rather the details that are relevant to the argument are transcribed.

The transcription of the interview data also involved two levels, with the second being employed in the write-up. The first was a prose transcription of the utterances of each speaker, while the second was a re-writing of each utterance into a verse form enabling the reading of phrases with short breaks at the end of each line as they would have been spoken (Extract 3.6).

Extract 3.6: Poetic transcription, Principal Interview

Principal: I am Afrikaans
as my home language is Afrikaans
um so
but I can make myself understood in English

Stage 2: Coding and prose interpretation

Concurrently with the generation of transcripts, I began to create a spreadsheet in which I logged each lesson and study group and the sub-topics and activity types which unfolded in each (see Addendum 8). I used Lemke's (1990) taxonomy of activity types as a reference point, changing or merging these as I needed and limiting my analysis to only those activity types which comprised Chemical Reactions topics. The final descriptions of topic-specific activity types in the spreadsheet are: teacher review, seatwork, groupwork, go over homework/seatwork/test, teacher exposition, media presentation, external text dialogue and testing. I noted also the start and end time of each activity type, using a contextualisation cue by the teacher indicating a shift in the discourse as a transition between activity types. While offering a helpful 'peg in the ground' to begin my theory-building, activity types did not hold enough explanatory power for the kinds of meaning-making I was observing among the learners. It was through the work of generating the activity types spreadsheet that the categories of meaning-making which I posit in Chapters 5, 6 and 7 began to emerge. This activity also helped me to critique and refine Lemke's notion of activity types in terms of their boundedness. I began to see that they could occur concurrently and were sometimes nested inside each other.

The prose interpretation at this stage focused on those moments of high semiotic significance for the participants and for my questions. An extract from the interactional data would be isolated and worked up into a level 2 transcript. From there I began to analyse the meaning-making practices that were salient in that extract using all the tools common to linguistic ethnography that were at my disposal. The microethnographic approach which I followed in this stage of analysis involved looking at an interaction in detail and considering all the modes of meaning-making to learn more about the broader social context of the classroom and society and how learning happens. These prose interpretations were then organised and re-organised into the data analysis chapters.

An example of prose interpretation is taken from data I have analysed in Chapter 5. A question taken from the class test gained high semiotic significance due to the learners' universally poor scores on their answers to it. This then caused me to trace the meaning of this question (in particular, one semantic relation upon which it depended) through the interactional discourse of the class lessons and study group. The validity of the arguments I make about

learners' meaning-making in this situation fulfil the requirements of validity in discourse analysis (Gee, 1999, p. 95) in the following ways:

- I searched the data for all examples of learners engaging with this semantic relation in all modes
- I sought the view of the teacher on the reason for the learners' lack of achievement on this question
- I sought agreement on the meaning of the expression of the semantic relation from my transcriber, working with translations of the expression.
- I unpacked the expression at a local linguistic level using the tools of Systemic Functional Linguistics, such as nominalisation.

In this way I fulfilled Gee's (1999) requirements for validity in discourse analysis following the principles of convergence, coverage, agreement and linguistic detail.

In Stage 2 of the data analysis, critical discourse analysis (CDA) was employed. CDA, championed by Norman Fairclough, pays close attention to how power in society comes about through processes which have a linguistic-discursive nature (Fairclough & Wodak, 2010, p.101). There are two major objectives in critical discourse analysis: first to understand how language and power are entangled in discourse, and second to look for creative ways through these entanglements to shift power relations. In terms of understanding the entanglements of power and language when analysing the interactional data, the documents or the interview data, I foregrounded the notion of positioning in utterances. The positioning of participants came about through the discourse used by them and about them in the context of the school context as a whole.

Stage 3: Formulating broad analytical categories and writing up

A challenge related to the use of microethnographic analysis in linguistic ethnography is that the researcher needs to keep the micro and the macro in view all the time. Early on in my analysis I thought that the two sites – the classroom and the study group – and the translanguaging practices I found within them would become my broad analytical categories. I hoped that this analysis would demonstrate how different language environments enabled

and restricted different resources. This became problematic in that it set up a false comparison between the sites, and between the teacher and myself, which could make my analysis read as if I were critiquing the teacher and valorising my own discursive practices. My microanalyses of the data also began to reveal different meaning-making categories which were common to both sites and so I settled on these as analytical categories: constrained, guided and spontaneous meaning-making, which have been described in Chapter 2.

Conclusion

This chapter has considered the methods I employed in the case study and has highlighted a number of key issues. Firstly, rather than ending when I received my ethical clearance, ethical considerations continued throughout the research project. Similarly, issues of validity and reliability were dealt with throughout the project and not just in the data analysis stage. Secondly, the principles of reciprocity and reflexivity as a linguistic ethnographer were revealed to be important in the case study. Thirdly, the process of transcription has been described in some detail as this has made a significant contribution to my theory-building. Lastly, linguistic ethnography has been identified as the key epistemological perspective which gives the study coherence.

In the following chapter I present my findings on the language environment which shaped the practices of the learners.

4 The language environment of Success High: ideologies and patterns of practice

> *The difference between monolinguals and bilinguals is that monolinguals are allowed to deploy all or most of their lexical and structural repertoire mostly freely, whereas bilinguals can only do so in the safety of environments that are sheltered from the prescriptive power of named languages.*
>
> - Otheguy et al., 2015, p.295

Introduction

In Chapter 2 I argued for a semiotic repertoire approach to the analysis of learners' meaning-making processes in a bilingual context such as Success High. My aim is to position learners' linguistic resources within their full semiotic repertoire and to analyse other modes of meaning-making such as gestures, actions and drawing especially in terms of how they are performed in concert with the linguistic modes. However, in this first chapter in which I present my data, I am limiting my discussion to the *language* environment of Success High. This is because it is the language environment – ideologies and patterns of practice - which has the most significant impact on which elements of the learners' semiotic repertoires become resources at school. The kinds of constraints and freedoms placed on the learners' linguistic resources are stronger than on any other meaning-making tool. So important are these constraints and freedoms that a policy exists to describe them: the language policy which is required by the South African Schools' Act (1996) and the Language in Education Policy (LiEP) (Department of Education, 1997). Seldom in any school will one find the kinds of constraints and sanctioning being placed on learners' gestures or drawing as one finds being placed on their linguistic resources. It is also the learner's oral language repertoire which is the most visible semiotic tool in the eyes of the institution of the school.

The language environment of Success High as I experienced it and participated in it in 2016 is the focus of this chapter. In Chapter 1 I sketched the language policy environment of schooling in South Africa and the history of the school. In this chapter I turn to an examination of language ideologies and patterns of language practices which were in evidence in my data.

This examination will provide an answer to my research question: What shaped the meaning-making practices of the learners? I will draw on fieldnotes, interviews, the language policy document and photographs taken around the school grounds as well as extracts from classroom and study group interactional data which is revealing of participants' language ideologies. I will focus in particular on the key participants in my study: the Principal, the Natural Science teacher, myself and the learners of Grade 9B. Perspectives from outside of the school community echo through the data at different points, and where they shed light on language practices I discuss them, but my focus is on what I observed during the school day on the school grounds.

I will discuss the following topics as they relate to each key participant:

- Language repertoires
- Language for learning
- School language practices: oral and written.

Language repertoires: ideologies and practice

All my data sources contributed to my understanding of participants' repertoires in three forms: texts (both oral and written) authored by participants; data in which participants discussed other participants' language repertoires; and direct questioning of participants about their repertoires. I am taking an ideological position by referring to 'repertoires', as outlined in Chapter 2. This is not the term I used with the other participants in the study. I became at times clumsy in my effort to use non-limiting but also accessible terms for language repertoires. In my interview with the Principal, my prompt to elicit her language repertoire was: 'ok, and so your language knowledge and um use, what languages do you speak?' (Principal Interview). Not wanting to limit her response to only those languages in which she felt proficient, I fumbled through 'knowledge', 'use' and 'speak' in my attempt to spread my net as wide as possible. Participants used the terms 'language capacities', 'languages' and the names of languages such as 'English' or 'isiXhosa' referencing a commonplace and more essentialised understanding of peoples' linguistic make-up. In the analysis which follows I draw attention to the ideologies which underpin the terms we use.

Principal's repertoire

During my interview with the Principal of Success High which took place right at the start of my fieldwork (Principal Interview) we discussed the three official languages of the Western Cape and the role they played in her repertoire. She began with what she called her 'home language':

Extract 4.1: Principal Interview. Principal's home language

P: I **am** . Afrikaans as
my home language is Afrikaans
um so
but I can make myself understood in English

Far from merely being able to make herself understood in English, the Principal is actually highly proficient in this language and it is the dominant language she uses at work. She underplays her strong bilingualism which is a feature of the coloured[29] community of the Western Cape (McCormick, 2002). This backgrounds her linguistic skill in two languages and constructs her as a monolingual, whose identity is bound up with home language ('I am Afrikaans'). This treatment of her Afrikaans and English was brief, although when I probed her on her use of Afrikaans at school, more detail emerged. I reminded her that I had overheard her speaking Afrikaans to a member of the grounds staff. She responded by indicating that both men responsible for the grounds were isiXhosa speakers who spoke better Afrikaans than isiXhosa. These were men with whom I myself had only spoken isiXhosa and so I had a limited knowledge of their repertoires. A further probe I used was stating that there were other home language speakers of Afrikaans on the staff. She responded to this by explaining the limits she places on using Afrikaans at school. She described how if she were speaking Afrikaans to a fellow speaker in the staff room and someone entered who was not Afrikaans-speaking, she would revert to speaking English 'just to include everybody and that they know that it's all above board'. This assumption that languages other than English being used in a multilingual environment such as this staffroom (of the 17 academic staff who were regulars

[29] In the Apartheid-designated people groups, 'Coloured' was the descriptor given to people who were not designated as 'White' 'Black'/African' or Indian. It was also sometimes used to describe people of so-called 'mixed' descent.

in the staff room that I polled, only three indicated English as one of their home languages) automatically constitutes exclusion and hints that something unsavoury or illicit is being discussed, is testament to the power of the ideology that English is a neutral lingua franca which includes rather than excludes (Phillipson, 2009).

The story of the Principal's isiXhosa part of her repertoire is one of language learned formally and informally. She reports having studied isiXhosa at university thirty years ago, but admitted that when 'you don't practise it it goes away' (Principal Interview). She added that the isiXhosa she learned was 'Oxford isiXhosa' and different to 'what I hear spoken here'. However, she reflected that she could 'get the gist looking at body language' and was able to respond in English to learners, staff and parents who spoke in isiXhosa.

In her interview, despite claiming a monolingual identity, the Principal reports on her multilingual life in which she uses adaptive strategies to negotiate a working environment in which the majority of the people are isiXhosa-dominant.

Learners' repertoires

I collected data on learners' language knowledge and use from the 36 members of Grade 9B through a questionnaire which is attached as Addendum 2. Key results are summarised in Table 4.1 below.

Table 4.1: Grade 9B language data from questionnaire

Linguistic category: open format questions	**Number of learners out of 36**	**Percentage[30]**
Learners identifying isiXhosa as a home language	36	100%
Learners identifying as 'knowing' more than one language	36	100%
Learners identifying isiXhosa as their only home language	24	67%
Learners identifying isiXhosa as one of multiple home languages	12	33%

[30] Rounded to whole numbers.

Learners identifying isiXhosa and English as their two home languages	6	17%
Languages 'spoken', 'known' or 'loved' by learners	isiXhosa, English, isiZulu, Sesotho, Siswati, Afrikaans, Sepedi, Japanese[31], Tshivenda, Setswana, Portuguese	

As the table indicates, the questions about language were formulated as open format questions with space for learners to include as many languages as they liked. Some of the questions probed reasons for their answers such as questions 1 and 2 below:

1. What is your home language/s?
2. How did you decide on your answer to 1? (eg. It is the language I use the most/ They are the languages spoken in my home.)

The table summary reveals that learners share much of their linguistic repertoires with all 36 identifying isiXhosa as one of their home languages. They also have highly heteroglossic repertoires with a third of the class (12) reporting having more than one home language and a plethora of languages listed as 'known', 'spoken' or 'loved' by the learners. This multilingual self-identification by the learners stands in stark contrast to the school's language policy.

My exploration of the school's language policy began during my interview with the Principal.

Extract 4.2: Principal Interview. Language policy

Turn	**Speech**
1 Robyn	do you have a formal written language policy for the school or not?
2 Principal	we do and it's basically a very short policy saying that um although the home language of teacher of the students may be um I can give you a copy of the policy
3 Robyn	that would be great, thank you
4 Principal	um but the language of learning and teaching will be English

[31] The learner who identified 'Japanese' as the language he loves the most is a karate buff. This highlights the affiliative aspect of language use which is well discussed by Rampton, 1995.

The Principal begins to talk about the policy by minimising its significance describing it as 'basically a very short policy'. This low-priority status of the school language policy aligns with Kgobe and Mbele's (2001) national study which found that only five out of 27 schools participating in the study had developed language policies (as cited in Probyn et al., 2002). The history of the Success High policy reveals the low profile and lack of interrogation of the policy within the school community - indeed it has not undergone much consultation - but that it serves to fulfil a legal requirement that the school has an official policy. The Principal informed me that the policy was written in 2015, has been 'seen by the staff', 'adopted by the SGB' and 'kept on file' (personal communication, 030216). She indicated that she was the primary author of the policy, but was informed by other schools' policies and a book on school leadership and management that she had been given. She reported that the learners have not read the policy and allowed that this was 'a shortcoming that we don't involve learners more' (fieldnotes 150416). Tacit language policies are however adopted by all members of the school community and some of these will be discussed in the next section, but the official written policy is revealing in terms of language ideologies in operation in the school.

In the above summary of the school language policy in her interview, the Principal frames the cornerstone of the policy as being the stipulation of the language of learning and teaching: '*but* the language of learning and teaching will be English'. Prior to that there is a concession given towards the home language of the teacher and students: '*although* the home language of the teacher of the students may be…'. Here she acknowledges the mismatch between the policy and the linguistic reality of the learners and teachers. This is consistent with the policy itself which recognises this gap. The policy states that the language of teaching, learning, assessment and communication with learners and parents will be English. It pits the 'linguistic capacities' of the learners against this standard in such a way that it sets up the concessions the policy will make to the learners' linguistic difference from the standard:

Extract 4.3: Success High language policy

> While Success High is an institution in which the medium of instruction and language of office is English, it nevertheless enrols learners with *divergent linguistic capacities*. (emphasis mine, p.1)

This description of learners' 'linguistic capacities' is vague. While I did not ask the Principal about the intended meaning of 'divergent', I assume it to be a malapropism with the intended meaning being closer to 'diverse'. However, either meaning presents a misleading view of the learners. Table 4.1 reveals that the learners of 9B share the linguistic capacities of isiXhosa as a home language and being strongly multilingual in the languages of South Africa. The descriptor 'divergent' hides the both the commonality of learners' repertoires and their richness. It also perpetuates the invisibility of isiXhosa as a main language among the learner body in the language policy. Indeed, there is only one reference to isiXhosa in the policy as a whole and this is in stating that it will be offered as a subject, only at home language level. In this way the language abilities of the learners as isiXhosa-English dominant multilinguals is obscured and replaced with a deficit view of their abilities. This view is repeated further on in the policy: 'all (sic) of our students do not have English as their Home language' (p.1). I assume an error above because the sense: '*not all* of our students *have* English as their Home Language' is more aligned with the voice of the policy in other places which gives the impression that it is only a portion of the learner body who do not have English as a Home Language instead of the reality that it is a vast majority (see Table 4.1). Indeed, as a self-identified home language speaker of Afrikaans, the Principal herself aligns with the majority of learners in this regard.

Further evidence of the deficit positioning of learners' linguistic repertoires is the absence of any questions about learners' languages on the school application form. Also in my early conversation with one of the teachers already reported in Chapter 3, I described my interest in the bilingual learners of the school and he retorted: 'How do you mean the learners are bilingual?' His lack of comprehension of my use of bilingual to refer to the learners at Success High indexes the invisibility of the learners' African language resources and also the dominant designation of 'bilingual' in South African education parlance which refers only to official English-Afrikaans bilingual models of education. This also creates a split along racial lines where white and coloured people are labelled 'bilingual' but black people are not.

These examples of an ideology which positions learners' language use as a problem, or deficient, is a common one all the way through the schooling system, as highlighted by McKinney (2017). McKinney argues that:

> the intimate relationship between language and power in schools works to position children from dominant backgrounds as legitimate language users while those from non-dominant linguistic, cultural and class backgrounds are frequently positioned as linguistically deficient. (2017, p. 63)

I have discussed how the 'non-dominant' isiXhosa resources of the learners are cast as a problem in the policy and the Principal's interview in that they are not English resources. McKinney also draws our attention to an ideology which positions any variety other than the 'standard' (ie. the variety used by the powerful in society, in this case white, middle class South Africans) as deficient and problematic. This 'monoglossic ideology' prevents the non-standard resources of the majority of learners being recognised in policy documents, government reports or language tests, where:

> the "normal" learner is imagined as already a competent user of the language variety that schools should in fact be giving him/her access to (ibid. p.64).

Overall, the Success High language policy suffers from a vision of its learners which is at a remove from their linguistic realities and the heteroglossic nature of practices in the school. This links to a broader syndrome in post-apartheid education policies as asserted by Christie and McKinney (2017).

> Post-apartheid education policies introduced a new narrative for education, based on an idealist vision of a transformed system. This policy narrative depended heavily on its vision, barely acknowledging the existing conditions in schools and classrooms let alone systematically addressing how they could be changed. (Christie & McKinney, 2017, p. 8)

Parents' repertoires

This monoglossic ideology is seen clearly at work in the Success High policy document when it turns to policy regarding communication with parents:

Extract 4.4: Language policy in relation to parents

> The Language of communication with parents shall be English, but steps will be taken to ensure that, while the standard of English is not compromised, the level of English

> usage shall not be such that it denies access to communication and comprehension by *those whose linguistic abilities in English are less developed than those of the average English home language speaker* (p.1, emphasis mine)

Even in this context on the fringes of academic activity the power of the monoglossic ideology is exerted. In the section in bold, we see the shadowy figure of the 'normal' or 'average' language user making an appearance. In the context of South Africa those who reported having English as a home language in the 2011 census totalled 9.6% (Statistics South Africa, 2012), the majority of these being white South Africans. It becomes difficult to see how the parents of Success High learners could ever be imagined to be 'average English home language' speakers. Furthermore, scholars have critiqued the notion of 'home language speaker' (Makoni & Pennycook, 2005) or 'native speaker' (Rampton, 1996) especially in a context of African multilingualism. Here I suggest the term is used as a cover for positioning the ethnolinguistic repertoire of Whiteness (McKinney, Carrim, Marshall & Layton, 2015) as the norm and desirable. This figure then only serves to appeal to an unattainable standard which positions parents as deficient. The anxiety about compromising the standard of English is particularly jarring in this context as what is at stake here is not learners' ability to cope with the curriculum or standardised assessments, but clear communication with parents.

In practice, the Principal flouts the English-only parent communication policy and uses languages and speakers resourcefully:

Extract 4.5: Principal Interview. Parent communication

Turn/ Actor	**Speech**
Turn 1 Principal	(laughing) so um let me talk about the parent-teacher meetings, ne? what I do is I have a teacher next to me to translate so our meetings take long (laughs) because everything is said twice
Turn 2 Robyn	right
Turn 3 Principal	and then when a parent wants to communicate to me then I allow them to speak in their mother tongue and I nod and I nod and I keep quiet and I don't nod if I don't understand (laughs) but um I allow them to just be free and and speak in their mother tongue and then I'll have somebody whisper in my ear this is what the parent is actually saying, so I don't want that to be a a a a sort of a stumbling block in our communication, with um letters I must admit that most of the

	letters are in English and I know that I I've tried where I translate the letter and I think last year I did couple of the letters but it's not very consistent
Turn 4 Robyn	and then the the one-on-one sort of meeting with you and a parent would you then conduct it in English because you don't have the
Turn 5 Principal	I'll I'll ask the parent whether they are ok in speaking in English
Turn 6 Robyn	right
Turn 7 Principal	and a couple of them would say yes and if not then I'll get another teacher with me
Turn 8 Robyn	ok
Turn 9 Principal	and then they can speak in isiXhosa and then we'll just translate so

In Turn 3, the Principal describes a number of techniques she uses to cross language barriers in communicating with parents: she uses staff as translators[32]; she prioritises listening in meetings even if her comprehension is limited and she has had letters to parents translated before. In all these measures she flouts the language policy to aid communication and establish trust with parents. The measures are journeys towards communication but are limited by the Principal's level of proficiency in isiXhosa (Turn 4) and by the dependence in the one-on-one meetings on the parents objecting to using English only (Turn 5), an act requiring high levels of agency from the parents.

Staff repertoires

While the staff was not the focus of my study, I did collect data on their language repertoires as well as their attitudes and beliefs about language at school as this has a bearing on learners' language use. I designed a written questionnaire and a shorter oral questionnaire, the administration of which has been outlined in Chapter 3. During my fieldwork one academic staff member left the staff and one new member joined. Both were included in my total

[32] Although the highly-skilled and crucial work of translation is not made conspicuous, and therefore undervalued, as a consequence of being received through a 'whisper in my ear' (Turn 3). This is in contrast to spaces such as markets where understanding between disparate language users is convivially managed, building rapport between these users (cf. Blackledge & Creese, 2017).

academic staff count of 23. Table 4.2 provides a summary of the 17 staff responses to my questions about language use. The other six members of staff were not available to respond.

Table 4.2: Language information gleaned from 17 of 23 academic staff (74%)

Language	Number of staff	Percentage
isiXhosa home language	8	47%
English home language	2	12%
Afrikaans home language	3	18%
Zulu or Setswana home language	3	18%
Shona and English home language	1	6%
Other languages known	Sotho, German, Dutch, Korean, Venda, Siswati, Ndebele, Sepedi	

In contrast to the learners of 9B whose home languages were significantly multilingual, only one staff member professed to have more than one home language. I posit that this is due to the principle of inheritance working more strongly in the adults and the principle of affiliation to new heteroglossic ways of speaking and being working more strongly in the teenagers (Rampton, 1995). Also notable in Table 4.2 is that only 12% of the teachers in my sample reported to be exclusive English home language speakers. This reveals that the staff body is closely aligned with the demographics of South Africa more broadly where 9.6% of people are English home language speakers (Statistics South Africa, 2012). In addition, the fact that the majority of Success High teachers have a home language other than the LoLT of English is closely aligned with the situation in the majority of South African schools (Probyn, 2001) where not only do teachers have the challenge of the mismatch between the learners' home language and the LoLT, but their own as well.

Ms B's repertoire

24-year-old Ms B reports her home language as isiXhosa. Her family is originally from Craddock in the isiXhosa-dominant Eastern Cape but she grew up in Cape Town and attended primary school in Kraaifontein and Khayelitsha with English LoLT throughout her schooling. She started high school at another school in Khayelitsha and then moved to Success High in Grade 10 and completed Grade 12 there. She qualified with a BSc in Microbiology and

Biochemistry and a PGCE in 2014 from the University of Cape Town and completed her teaching practice at an ex-Model C school in the suburbs and at Success High. In 2015 she took up a Natural Science position at Success High. At the time of my fieldwork she was in her second year of teaching at the school. While her interview responses are included in Table 4.2, more detail is available on Ms B's language repertoire which is pertinent to the study. My first prompt about her language repertoire opens the following extract.

Extract 4.6: Teacher Interview 1. Language repertoire

Robyn: and then I'm interested in your
your languages that you know and that you speak and you use
Ms B: ok
Robyn: um
can you tell me a little bit about that
Ms B: um well
home language is isiXhosa for starters
and then I teach in English
well I speak English most of the time
I can say and only a couple of times or with a couple of individuals that I speak Xhosa with

After English and isiXhosa, she said that she doesn't speak any other languages, but then further on in the interview added 'Xhosa is so similar to Zulu' and 'the people from Joburg their Tswana I can understand'. Ms B's multilingualism requires some probing to uncover. She learnt Setswana from her room-mate at university. She also mentioned picking up Afrikaans from the area where she lives in Somerset West and she studied the language in school. She speaks mostly isiXhosa with her granny and her mother, otherwise she speaks mostly English. That Ms B's multilingualism requires probing to uncover points to the unmarked nature of African people's multilingualism (Makalela, 2016) and that Ms B is not used to valuing her multilingualism.

I asked Ms B about her language use on social media:

Extract 4.7: Teacher Interview 1. Social media language

Ms B: (laughs) I think honestly just use English um with most people

Robyn: ja, ok

> Ms B: because, especially with typing and whatever its so much easier than Xhosa, I think you'd rather speak Xhosa than write it (ok) it gets really complicated so if I'm texting if I'm well Twitter or whatever I would use English cos it's a shorter and whatever

Ms B has a strong affiliation (Rampton, 1995) with English as revealed through her use of 'easier' versus 'really complicated' for using isiXhosa on social media and, as my observations showed, her almost exclusive use of English in Natural Science class. When I ask her where and how she learnt English she laughs and says 'what do you mean' and 'I honestly don't know how to answer that' (Teacher Interview 1). Her discomfort with my question could be due to her learning of English being dispersed in time and space throughout her life, from primary school onwards. She reports that she didn't feel confident in English on leaving primary school, only after high school, the whole of her school career was a steep learning curve for her. This moment of discomfort also occurs against the backdrop of a power differential between myself as an English-speaking white interviewer and herself as black interviewee having to account for her proficiency in a language through which she must make her living. Certainly, her experience at high school was difficult given the English immersion environment of the Success High classroom, as she goes on to describe:

Extract 4.8: Teacher Interview 1. English at Success High

> T1 Ms B: well I didn't want to at first like I I hated the idea of coming here (Success High) I felt like I was forced to come here
>
> T2 Robyn: whose idea was it then
>
> T3 Ms B: remember (the headhunters) yes they went and approached the school so basically everyone at the school the teachers were saying I should go and whatever and whatever (in-draw of breath) so but I didn't want to cos you know your friends are there and everyone (I: yes) so now you thinking it's just gonna be me at this new school and ja but ja I was forced to come (I: m)but I didn't enjoy it for maybe like the first month or so until I started well be comfortable and get used to the environment (I: mhm) and then after that it was it was fine it was ja (in-draw of breath)
>
> T4 Robyn: And do you remember feeling a bit at sea with, with all the English, do you remember it feeling like a much more English than you've ever been exposed to and now you learning through English and it's difficult or or what was it like?

T5 Ms B: Ja, I think it, that's how I felt throughout the high school (laughs) yeah, yeah I think that's how I felt, like there was something to learn each year and mmm sometimes it was a bit too much

Ms B's bodily expressions of discomfort (in-drawing breath, Turn 3) as well as the strong expression 'forced to come' (Turn 3) reveal that the integration into English-dominant education was difficult. This experience affects her ideological position on language for learning to be discussed later.

Ms B's language use is discussed much more informally during the final study group meeting. I have been asking the learners about different people's language use in class and this extract opens with my direct question about Ms B's language using the formulation for 'speak English' from the learners' familiar register, 'uyakhumsha'.

Extract 4.9: SG8. Ms B's language

Turn	Actor/Action	Speech	Gloss
1	Robyn	UMiss B uyakhumsha nje?	Miss B speaks English only
2	Thandile	Yhu Ewe	Yes
3	Yonela	But simphendula ngesiXhosa xa sifunayo nje	But we answer her in isiXhosa when we want to
4	Thandile	Ewe, ngamany'amaxesha athethe ngesiXhosa	Yes, she speaks in Xhosa sometimes
5	Robyn	Ok ok, so uMiss B uyakhumsha nje	Ok ok, so Miss B just speaks English
6	Thandile	//At first I thought she's was like white//	
7	Robyn	//You're not aware of that//	
8	Thandile	Nooo and even like my mom asked	
9	Robyn	Did you have your eyes closed at that time?	
10	Thandile	(laughs) No Miss	
11	Learners	(laughter)	
12	Thandile	I thought like she was mixed or something cos even my mother came home the other day from meeting and I was like Miss B Miss B like speaks English or something	
13	LM	She's really speaking English	
14	Thandile	She's fluent	
15	Mbulelo	Fluent in which?	

16	Robyn	You are you're also all fluent but uh I so so say more about her English?	
17	Thandile	Yoh she like yoh she like it's like	
18	Robyn	What do you say?	
19	Thandile	She's smooth in English like like it's her mother tongue	
20	Robyn	Ja, no it's hard to find a word of Xhosa that she says (Thandile: and and) and you didn't mention it when I asked you who speaks what in the class	
21	Thandile	And it's funny to hear Miss B speak Xhosa in class cos the other time like during break like 'Thandile ndicela undiboleke i-pen'	Thandile please lend me your pen
22	Yonela	'Hey Yonela Yonela yintoni le uyenzayo'	'Hey Yonela Yonela what is this that you're doing'
23	Thandile	E-e! But it's very funny	Yes
24	Robyn	Very strange, ja, Ok	

I want to draw two points out of this multi-voiced discussion. The first is the interest the learners show in their teacher's language use. Within the first few seconds of my asking the question, Thandile and Yonela have provided three distinct opinions or observations on Ms B's language. They go on to provide elaborations and quote their teacher directly to give examples of her language use. Thandile displays high interest through affect-laden interjections which demonstrate the intensity of his opinion ('yhu' Turn 2; 'yho' Turn 17). The second point is the complex way language and race are intertwined for Thandile. His concept of race in Turn 6 is more nuanced than the one I express to tease him in Turn 9. He uses the adjective 'white' to reference a potential biological explanation for Ms B's language use. He implies that perhaps she has white ancestors. He later changes his racial term to 'mixed' (Turn 12), still citing that her proficiency in English as the reason for his categorisation of her in these racial terms. Ms B's accent when speaking English aligns more closely to what has been described as White South African English (WSAE) (McKinney et al, 2015; Mesthrie, 2010) than her learners'. This for me is the most marked difference between her and their 'English'. However, these learners do not refer to accent, rather they use the following qualifiers and adjectives: 'she's really speaking English' (Turn 13), 'she's fluent' (Turn 14), 'she's smooth in English like it's her mother tongue' (Turn 19). This favouring of Ms B's linguistic features reveals a prevalent monoglossic ideology which favours phonological features associated with

white speakers. The use of 'smooth' in relation to features of WSAE has been reported in other South African school discourse data (McKinney, 2007).

My repertoire

I identify as a home language English speaker. I have substantial knowledge of Afrikaans and good productive and receptive ability in oral and written modes. I currently produce Afrikaans less often than I do isiXhosa. I have a fair knowledge of an urban variety of isiXhosa and use it conversationally and to read isiXhosa children's books and listen to radio programmes for my own language learning. I have very limited knowledge of any other language. As reported in Chapter 3, I used isiXhosa at Success High as much as possible. I conversed with administrative staff and learners in isiXhosa outside the classroom, and used it in a limited capacity in the study group. My limited capacity to use isiXhosa to learn Science certainly contributed to the English dominance of the discourse data collected in the group. I wished I could have used more isiXhosa. However, being a learner of the language also had its advantages in positioning me as a learner, in effect turning the power binaries of teacher-learner and white person–black person on their heads. It also evoked metadiscourse about isiXhosa which drew learners' attention to their own language use. I was also something of an anomaly as a white person who could speak some isiXhosa. Certainly, I never heard another white (or coloured) person speaking isiXhosa at Success High during my time there. Hence, I was immediately an object of some interest and an oddity.

At the first study group meeting I felt nervously determined to use isiXhosa myself to model bilingualism and so establish this as an alternative languaging space. The extract below follows my first greeting of the learners and the ensuing moments. I had previously met them in class to introduce my PhD study and the study group.

Extract 4.10: SG1. Weird language (screen shots taken during bolded utterances, I face the camera, Khethiwe sits closest to me)

T1 Robyn: **Ninjani?** (how are you all?)

Frame 1

T2 Khethiwe: We:ird.

T3 Robyn: **Weird?**

(some laughter)

Did you say "weird"?

(some more laughter)

That's an unusual answer to the question

"how are you?"'

(even more laughter, including Robyn)

Are you weird today?


Frame 2


Frame 3

This interaction – or rather false start - in the first few moments of the inaugural study group captures some of the poignance, vulnerability and awkwardness of my role at Success High. The people pictured around the table in the library are in uncharted territory. My utterance in T1 is out of place on three levels. Firstly, I am a white South African greeting black South Africans in their home language, which is an act against the grain of the stratification of social power which was set up by Apartheid, namely that the language of white South Africans predominates in interactions between white and black people (Botha, 2012). This is a rare occurrence in our society. Secondly, in a semi-formal teaching and learning space I am a teacher opening the interaction in an African language. The third level exists as a compound of the first two levels, bringing a unique strangeness to the interaction. I am a white English home language South African teacher greeting black isiXhosa home language learners in their home language in a content subject teaching and learning space which is never imagined as anything other than English dominant.

I am prepared for my 'out-of-place'ness in that I have had time to prepare for my fieldwork and observe learner speech patterns. Learners are unprepared for me, especially my ability to speak isiXhosa, and Khethiwe's response (T2) is refreshing and out-of-place in equal measure. It is out-of-place in that learners do not habitually respond to 'teachers'' discourse evaluatively, yet it is a disarmingly honest emotional response. It is also an opportunity for Khethiwe to perform important social identity work as a peer of the other learners. By enacting youth slang (T2) and upstaging the teacher through diverting the attention from my utterance to hers she presents herself as a socially powerful member of the peer group. My reading of her desire for the recognition of this identity is strengthened by her gaze cast towards her friend with the concomitant smile of success (Frame 3).

I allow her response to 'hang in the air' by repeating it (T3) which allows space for other learners to respond, which they do tentatively by laughing softly. Then I put on naivete, playing the sincere language teacher, while at the same time revealing my disguise by leaning forward and joining in the laughter (Frame 3). Through this joke I am trying to win rapport and therefore trust. The discussion continues as I risk an explicit discussion of race.

Extract 4.11 SG1. Language and race

Turn	Actor/Action	Speech	Gloss
1	Robyn	Ja ndithetha...Ndifuna ukuthetha kanjani ne?	Yes, I speak Xhosa. I want to speak isiXhosa how, hey?
2	Nandipha nods		
3	Khethiwe	Freaky	
4	Robyn	Why is it so weird? You've never seen a white person speaking Xhosa?	
5	Khethiwe	No, I've never imagined you speaking Xhosa //that's why//.	
6	Robyn	//But I already//spoke Xhosa in your [class].	
7	Ls	Yes	
8	Thandile	But in class	
9	Robyn	Kancinci nje nhe?	Just a little bit
10	Learners	Ja.	

My opening the conversation in isiXhosa (Turn 1) does little to unsettle the school norm that learners speak English with white adults. There are two possible reasons for this. First, it is so unusual for a white person to use isiXhosa in communicating with a black person in the Western Cape that Khethiwe remains in the convention of English for white interlocutors. Second, Khethiwe herself is unusually invested in speaking English and as she is the first respondent to my question she sets the language of further engagement. Then in Turn 4, I introduce the question of race and language use. This is avoided by Khethiwe. Perhaps this involves too much risk for her: negotiating the ground rules of this subject in discussion with a newly acquainted white adult is too complicated. She quickly brings the subject round to me as an individual. Just as my use of isiXhosa is limited by my proficiency and the learners' willingness to converse with me in that language, so my struggle to talk about the elephant in the room is limited by taboos around talking about language and race in certain public spaces in South Africa. Kell (2010) reminds me that this is not an unusual predicament for South African linguistic ethnographers:

> South Africa is a country that is still very divided. Ethnography offers a way into understanding such divides. In South Africa it is not an easy way. At the same time as it 'entails trust and confidence' (Hymes 1996, p.14), it also involves grappling with issues of identity and risk. (Kell, 2010, p. 231)

Language for learning: ideologies and practice

Under the broad heading in the school's language policy 'Language of Teaching, Learning and Communication', English is stated as the 'medium of instruction' and 'language of office'. A reductive naming of a language or languages of learning and teaching is all that the LiEP requires in this section of the policy. Unpacking the complexity of 'language for teaching and learning' is not explored in this document and is not well understood by schools or government officials and ill-supported by the DBE (Probyn et al, 2002). The medium of instruction is repeated in a later section as English. Apart from a concession towards 'students (who) do not have English as their Home language', this is the final word on the language of learning and teaching. The silence around isiXhosa renders all the use of isiXhosa I observed and engaged in during teaching and learning at Success High inexplicable, even deviant, in the

eyes of the policy. This rigidity in the face of a complex activity such as teaching and learning, particularly in a bilingual environment, is an example of a process that McKinney describes which results from monoglossic (and I add Anglonormative) ideologies. She argues that these ideologies:

> misdirect our attention from the real problems in language and literacy teaching (and this) "misrecognition" of the problem also prevents productive solutions through heteroglossic approaches to language use (2017, p. 71)

One of the real problems in language and literacy faced by the staff and learners of Success High is that the learners arrive at the school having been exposed to limited teaching in English in their primary schools, despite universal English LoLT from Grade 4 in Khayelitsha primary schools, as the Principal explains in Extract 4.12.

Extract 4.12: Principal Interview. Primary schools

> Principal: they say yes it is the case that their primary school teachers actually teach in isiXhosa because it's more comfortable for them to speak in their mother tongue than in English which is a foreign language for them probably.

Despite this acknowledgement, the entrance tests which prospective Success High learners write in English, Mathematics and Natural Science are all in English resulting in the tests all becoming predominantly English language proficiency tests and not tests of content knowledge.

The 'real problems in language and literacy teaching' and their 'productive solutions' (McKinney, 2017, p.71) at Success High are addressed with discomfort and difficulty and little consensus in my interviews with staff members and in the results of the staff questionnaire in the following sections. Hence, beneath the veneer of a simple language policy, there lies contestation and struggle over language in teaching and learning practice.

Staff's language for learning ideologies

Towards the end of my fieldwork, I gave an oral report back to the staff on my study. One of my main aims was to share some of my data with them which revealed the oral meaning-making practices of the learners that they are usually not privy to. Just prior to question time I had shown a transcript of the study group in which learners became engaged in constructing a scientific investigation (discussed in Chapter 6). The final learner utterance appeared on the data projector as follows: 'What do wood free coloured pencils made of'. I then closed my presentation and asked my audience if there were any questions. The Head of Science who was still gazing at the transcript on the screen grimaced and asked, 'is that even a sentence?' (fieldnotes 010816). I tried to hide my disappointment[33] that what turned out to be the only question about my presentation was focused on the learner's use or non-use of standard English thus revealing a clear monoglossic ideology and included no reference to the nuances of meaning-making which I had taken pains to point out in my presentation. However, what the question also revealed was the hyper-vigilance of teachers in this context to the use (or lack thereof) of the conventions of Standard English, even in spoken form. Teachers are sensitive to the power that this variety holds in society and the pressure they are under to provide access to it in schools (Janks, 2004).

Questions and comments like the aforementioned occurred from time to time during my fieldwork. The questionnaire was a more formal tool to capture attitudes towards language for learning. Of the 17 academic staff who responded to my questionnaire, five also completed the more detailed written questionnaires (see Addendum 3). Two of the questions related directly to language for learning. The written answers given by the five respondents are transcribed below each question. The subjects taught by the teacher are given in brackets after their pseudonym.

1. Do you have any rules about language use in your classroom? Please describe briefly.

    T1 (English enrichment): Speaking English is compulsory.

    T2 (English): English as far as possible.

[33] I fortunately discovered that I wasn't alone in being disappointed after sharing data with professionals. Fiona Copland noted how professionals will 'often use the data to forward their own agendas rather than to discuss the features I have introduced' (Copland & Creese, 2015, p. 112).

T3 (Mathematics): We must only use English in the classroom. You cannot learn Mathematics in another language as it will be tested in English.

T4 (Life Science): If a learner wants to express him/herself in the mother tongue, I would allow them to do so - for short spells.

T5 (Geography and English): I know I'm supposed to enforce that only English is used in class, but I feel that they are helping each other more in their own language.

2. Do you experience any challenges relating to language in your classroom? Please describe briefly.

T1: Learners struggle sometimes to express themselves or explain in English.

T2: Learners are prone to revert to their mother tongue when they struggle to express themselves. They converse in their mother tongue with one another even during the English lesson.

T3: Some learners find it difficult to express their views in English.

T4: It may contribute to relations if teachers have an understanding (basic) of the mother tongue of learners at a school. It will also be helpful if teachers use mother tongue words, phrases (indigenous) to help explain complex concepts.

T5: Sometimes students do not know a word but they just ask another student and the word always comes.

Although this is a small sample of the academic staff (22%), the answers to these questions reveal influential attitudes and beliefs about language use in the classroom. All five teachers described oral language practices, which reveals that it is the dominant communication channel of the public space of the classroom and is at the front of these teacher's minds when reflecting on language practices. Two teachers (T1 and T3) report that they insist on exclusive English use in the classroom. The other three teachers express more nuanced language rules with conditions attached ('for short spells'; 'as far as possible') or awareness of how practice diverts from school language policy ('I know I'm supposed to enforce that only English is used'). The unspecific and concessional language rules governing classroom practice used by these teachers are aligned with the anxieties expressed by the Principal regarding classroom language practices which will be discussed in the next section. Even when teachers expressed clear and confident language policies in their classrooms, there may be more complex practices happening in reality. One Science teacher whom I met early in my fieldwork was very confident about her language use in the classroom. I met her in her classroom and she

explained her adjustments to the language use in her classroom while three Grade 11 learners worked on homework in a group near us. The following extract is taken from my fieldnotes:

Extract 4.13: Fieldnotes, 191115

> She said she used to use a methodology of getting her learners to translate explanations to each other in Xhosa, but now doesn't use that anymore, rather she asks them to explain to each other in English. She says this is better. When she asks some learners in the classroom if this is better they give a much more hedged answer. They seem unsure. … I ask the learners in the classroom what language they are using to discuss the science problems they are working on and they say 'we are mixing'.

Overall, staff comment on the language practices they employ in classrooms often reveal more about their own language ideologies than actual practice.

The Principal's language for learning ideologies

Following directly from the brief overview of the language policy given by the Principal in her interview (discussed above), she begins to broach the topic of the role of 'code-switching' in teaching and learning. She has been informed about my research topic by way of a letter and informal conversations we have had previously and this is probably the spur to her introducing this topic.

Extract 4.14: Principal Interview. Code-switching

> Principal: And it's um we we we do um allow and possibly encourage code-switching if it will help the understanding of the students but there are certain teachers that can't code-switch for me for instance I can't I know certain words in English but I think I'm gonna do more damage if I want to use a Xhosa word to explain things (laughing) more harm than good you see, so there are certain people, we have Zimbabwean teachers we have um teachers that cannot speak isiXhosa um so the the code-switching in the sense to help them understand the work better by explaining it in their mother tongue, that doesn't really work for for us who don't speak isiXhosa

The Principal's speech here is hesitant and hedging. She hesitates through repeating 'we' in the first line and hedges through the use of 'possibly'. This is a topic about which she feels some awkwardness and possibly irresolution. She also acknowledges those staff (including herself) who can't do this as they are not proficient in isiXhosa, recognising their lack in this

regard. She continues to describe her informal directives to staff about code-switching as follows:

Extract 4.15: Principal Interview. Code-switching continued

> T1 Principal: I didn't I don't explicitly say um when I but in the staff meeting that code-switching is allowed but when I do speak to individual students I feel that there is a place for code-switching um … if say a Xhosa speaking person would speak to students and they have difficulty explaining a concept or they have difficulty not explaining the concept let me just not say it that way, they have difficulty getting the kids to understand a particular concept, but they know that there is a word in Xhosa that will make them just easily understand it they they can say they have the vocabulary to say it in English but the kids they don't grasp it (Robyn: m) but when they just have the word or the phrase or the idiom in isiXhosa that will make the kids grasp it and see the picture clearer then that is that is quite acceptable for me, so I'll when I speak to individual um people then I'll do that however when I do my rounds and I hear people teach in isiXhosa then I will speak to the teachers about that because you not supposed to teach in isiXhosa
>
> T2 Robyn: …so what's the difference in your mind between...teaching in isiXhosa and . teaching in English with some code-switching when when understanding is difficult
>
> T3 Principal: you see, what we need to um we we let me let me put it to you this way, when the kids come here they some of them actually have difficulty conversing in English (Robyn: m) but at the end of grade 12 and that is their passport basically for higher education, all the exams are going to be in English and our job is to make sure that they understand the work in such a way that they can express it (Robyn: m-hm) in English correctly

The Principal here reveals nuanced ideas of code-switching and an ambivalent attitude towards it. In the first turn she focuses on the need for her learners to 'understand', 'grasp' and 'see the picture clearer' in their classes. However, she makes it clear that the use of isiXhosa should be limited to a 'word', 'phrase' or 'idiom'. In other words, the use of isiXhosa is a concession towards learners to ameliorate lack of understanding, but it should not become dominant or visible as a resource. Condoning the use of code-switching publicly in a staff meeting is going too far for her. However, when probed (Turn 2) to provide a distinction between 'teaching in isiXhosa' and 'teaching in English with some code-switching' she avoids answering the question and rather moves on to the topic of 'our job'. She understands this to be the responsibility of herself and her staff to the learners, to make sure that they 'can express (their work) in English correctly'. The reason for this she gives is the high stakes in

higher education placed on English proficiency. The ideal of preparing learners for a world of English dominance is a safer topic than dwelling on the messiness of the mechanics and politics of teaching and learning in situ with the multilingual reality of her classrooms. Her discomfort can be described in terms of the double burden that teachers in English-dominant multilingual contexts are under where they have to balance the pressures of providing access to new concepts and to the language of power (Setati & Adler, 2000).

The Principal's view on code-switching is pivotal as the leader of the school. Also, I think her views here are representative of many South African teachers who hold strong opinions, but do not have a nuanced understanding of the practice of the use of different languages in teaching and learning. This has been attributed to the lack of penetration of recent developments in applied linguistics in education research in general and therefore into teacher education programmes (Guzula, McKinney & Tyler, 2016).

Ms B's language for learning ideologies

In reflecting on her journey of acquiring English, Ms B identifies being 'forced to talk to speak in English' at school as pivotal in her acquisition of English.

Extract 4.16: Teacher Interview 1. English at school

> Ms B: I think I would say obviously in primary you had to like try and whatever but um I wasn't comfortable with it [speaking English] I think until I came to Success High so around Grade 10 whatever so yes I used to speak it before that but it wasn't as comfortable… and actually um some of the teachers, not some most of the teachers were teaching in Xhosa and which is why I didn't like that because um the only time learners get to be exposed to English is in class and now if in class you still are not going to like teach them in English, I remember even our English teacher was teaching us in Xhosa, Biology, Xhosa, you understand, so it never gets to a point where you feel ok I am comfortable with the language until you actually are forced to talk to speak in English and whatever, so.um. I think maybe that forces learners to to learn it at a (indistinct) late stage if I can say cos Grade 10 if maybe you are only gonna get comfortable with English in Grade 10 that's a bit late

But as discussed, Ms B describes her own experience of an 'English' high school environment as 'too much' and agrees that she felt 'at sea' and that it was 'difficult'. This experience of coming into an environment with much more English than she had ever been exposed to, formed the basis for a discussion of the learners' language use.

Extract 4.17: Teacher Interview 1. Learners' language use

> T1 Robyn: and do you see, do you notice in your learners a similar experience of suddenly coming across a lot of English when they come (Ms B: ja) into Grade 8
>
> T2 Ms B: eish, ja it's actually the problem with Grade 8 I think also they had a similar experience with not being taught in English and whatever cos with some of them I would see that they do not have a problem with the work, but they have a problem with the language and even in class if I ask questions no one wants to answer and whatever until I ask cos I usually ask is the problem with my question or is it the language then they will always say it's the language and then they will say can we please answer in Xhosa, you understand
>
> T3 Robyn: and then what do you say
>
> T4 Ms B: uh sometimes I say yes sometimes I say no (Robyn: ok) but uh what what I'm trying to do is is to get them comfortable um I like I give them talks and whatever it's fine if you make mistakes its fine um that's what you here for so I'm just hoping like the Grade 9s um by we can even say 10 too it's not like a big of a thing by 10 too they should at least um be able to uh well not feel the need to speak in Xhosa every time like try and try to express themselves in English cos that really the only way they gonna learn (Robyn: m)

Ms B's language strategies in working with her bilingual learners include: sometimes allowing isiXhosa to be used, sometimes insisting on English, giving her learners motivational talks to encourage them to use English. Her overall goal is for them to speak as much English as possible as she believes this is 'the only way they gonna learn' (Turn 4).

She diagnoses the learners' difficulties as follows: 'they do not have a problem with the work, but they have a problem with the language' (Turn 2). She explains how they often have correct answers written in their books, but will be reticent to give the answers orally. This separation of 'work' (ie. content) and 'language' is revealing of Ms B's pedagogy which holds that English is something the learners need to work on orally and by their own volition and that by doing this they will improve in their ability to express Science concepts. This contrasts with the view of language and learning which holds that language is learnt in context, which in this case is the Natural Science topic under study, and that this language can and should be taught through metalinguistic teaching – ie. explicit reference to aspects of grammar and lexicon associated with Science. When pressed about learners' ability to write in Natural Science Ms B allows that it is mostly 'definitions' that she marks and not any 'creative writing' or 'using

their own words' (Teacher interview 1). The only exception to this kind of writing she finds is in the mandated activity, Investigations, where learners have to use extended writing to express, for example, the conclusions they have drawn. The kind of writing that Ms B describes as being appropriate for Natural Science is what Lemke calls 'fixed words' (1990, p.91). He warns against this as the only kind of language production being offered to learners and prefers 'flexible words' or in Ms B's terms 'using their own words' in which more meaning is made.

The content of our interview dialogue about language in learning consisted of language used to teach and learn in the plenary environment of whole class talk as well as less dominantly language for written work. Ms B did not comment on language used in group work or one-on-one interaction with her learners. An experience I had in class one day reinforced for me that this kind of languaging did not constitute 'real' teaching and learning for her. In my fieldnotes I wrote about an interaction I had with Ms B half way through a one-hour period of Natural Science:

Extract 4.18 Fieldnotes 080316

> Teacher took off recorder and gave it to me and I said, 'no, what you doin' and she said, 'oh, I thought the lesson was over'.

Ms B's understanding was that once she had ceased to lead the whole class discussion from the front and began to engage in one-on-one conversations with the learners about their work, I would not be interested in capturing that talk on the recorder because 'the lesson was over'.

The language policy, Principal and teachers seem confident about what constitutes unacceptable practice regarding the use of isiXhosa, due to Anglonormative and monoglossic ideologies and standardised assessments, but less clear about what is acceptable practice. The lack of clarity results in an ill-defined approach to the use of language for learning in the school or individual classrooms and this has been shown to result in an ad-hoc and often guilt-ridden use of learners' home language in teaching and learning (Probyn, 2009). The tension between official language policy and practice is equally strong for learners. The following section highlights some of this tension.

Learners' language for learning ideologies

The language for learning part of the learners' questionnaire focused on language preferences and self-evaluation of language proficiencies. Because, as shall be described in Chapter 5, the learners operate in a system which is highly constrained in terms of meaning making, I wanted to shift the focus onto their own learning processes and to provide for some nuance in the language choices on the questionnaire. Heugh (2002) discusses how the Department of Education and Training language policy survey of 1992 and the Pan South African Language Board survey of 1999 found that when African language-speaking parents were given a choice which included both English and the home language used as LoLTs, the majority opted for this. Taking direction from these surveys, I created a learner questionnaire which was as nuanced as practicable.

As the questionnaire was a minor data gathering tool within my data set, I limited the number of questions I used and only used open questions five times. The third variable in Table 4.3, below, included an open question for learners to give reasons, which will be reported on in the next section. 'In Natural Science lessons, do you prefer working in (tick) English, isiXhosa or both English and isiXhosa? Why?' In offering these choices on my questionnaire, I describe a situation which the school's language policy does not imagine, and therefore a transgressive, but also hopeful possibility. This is strongly indicative of the advocacy arm of my study.

Table 4.3: Language proficiencies and preferences in the 36 learners of Grade 9B.

	English	**isiXhosa**	**Both English and isiXhosa**
1. Language in which you read best (open choice)	25	7	4[34]
2. Language in which you write best (open choice)	19	13	4

[34] Of these 4 learners, 1 included Zulu amongst the languages she reads best.

3. In Natural Science lessons, I prefer working in: (restricted choice)	9	2	25

Using the data in the table, I will discuss firstly, the differences in learners' self-identified proficiencies in reading and writing languages and secondly, that there is a majority preference for both English and isiXhosa for learning Natural Science.

When we consider learners' semiotic repertoire on which teachers can draw in the classroom, we can consider resources for both productive and receptive meaning-making. Those who chose isiXhosa as the language in which they write best (13) was nearly double those who chose isiXhosa as the language in which they read best (7). The majority selected English as the language in which they read best. These differences, while not probed in the questionnaire align with frequency of language use in productive and receptive modes in these learners' schooling. Learners have many more opportunities to read English than to write it. Equally, reading material in isiXhosa is scant. On my first visit to the school library which is well stocked, I could find only 42 fiction texts in isiXhosa and no non-fiction texts. This is in contrast to the shelves and shelves of English texts. In an informal chat on meeting the librarian she gave some reasons for the dearth of isiXhosa books. This is encapsulated in my fieldnotes on that day from which I quote:

Extract 4.19: Fieldnotes 030216

> I teased her about there being so few Xhosa books and she said, yes, she realised the dearth after Mrs George left (she also ran the library). She said she struggled to find good Xhosa books. Some she found (Fundza series), and the teen romances went 'flying out' of the library. The problem was that they didn't come back! (Isn't this a good reason for buying more?!)

The second point that Table 4.3 highlights is that a majority of learners (69%) would like to use both English and isiXhosa to work in Natural Science class, with only 25% preferring to work in English exclusively, despite the school's exclusive English medium policy. The reasons that the learners gave in part 2 of this question have been summarised in table form below.

Table 4.4: Learners' reasons for language choice for working in Natural Science

Language preference for working in Natural Science	**For language reception ('understanding')**	**For language production**	**It is a universal language**	**It is the language of assessment and the academy**	**Easy/ preferable**	**No reason given**
Both English and isiXhosa	17	2			5	1
English	4	1	2	2		
isiXhosa	2					

Here we see the majority of responses (66%) invoke understanding of the content of Science as the main reason for the preference of language of learning, whether this is English, isiXhosa or both, although the majority of these opted for both English and isiXhosa. If we assume that those who wrote that they 'like' using both, or that it is 'easy' to use both, were referring to understanding as well, then this majority is even greater. This aligns with the discourse data from the class lessons which showed that isiXhosa was being used primarily in class to work on understanding orally when the learners discussed their seatwork with each other. Important here too is that an equal number of learners who opted for English only for use in Natural Science work, did so for understanding as those who did so for external factors such as access to tertiary education and because the assessments are in English.

Further evidence of these language preferences and proficiencies of the learners was present in the interactional data. Orientations towards English were expressed both through the voice of authority as well as through the 'underlife' of the classroom (Guiterrez, Rymes & Larson, 1995). During the first lesson which I observed, learners would frequently call out 'speak English' (fieldnotes, 270116) to each other if someone spoke using isiXhosa in the public space of the classroom. This public policing of each other's language use only occurred during that first lesson I observed and fell away after that. A reference to English which was more ludic and provided emotional release through humour occurred during Class 3 (150416). A boy called out after Ms B had uncovered their prior confusion over a concept, 'We were bhided

by George' ('We were confused by English'). This episode is described in detail in Chapter 8, but suffice to say here that this is an irreverent and playful reference to English through personification and the struggle of understanding Natural Science through this medium.

The informal discussions we had in the study group provided further opportunity to probe language attitudes. In the first study group meeting there were nine learners present. Shortly after the meeting started, the learners and I embarked on a discussion about which languages are useful for speaking about Science. This conversation reveals much about the learners' different notions of what it means to speak or even do Science.

Extract 4.20: SG1. Language for Science

Turn	Actor/Action	Speech	Gloss
1	Robyn:	Masithethe kancinci. Uyakwazi ukuthetha iSayensi ngesi ...ngesiXhosa?	Let's talk for a little bit. Do you know how to speak Science in… in isiXhosa?
2	Learners, shaking heads	Hmh.	
3	Robyn:	Huh?	
4	Nandipha	(Indistinct)	
5	Robyn:	Nithetha isiNgesi nje?	You speak English only?
6	Nandipha nods		
7	Phumeza	Ndingazama.	I can try
8	Robyn:	Hey? You've never spoken Science in Xhosa?	
9	Learners, shaking heads		
10	Khethiwe	I try. always fail.	
11	Robyn:	Where do you try?	
12	Khethiwe	At home (indistinct) day to day.	

13	Robyn:	Then why do you fail?	
14	Khethiwe	Because I don't know most of isiXhosa, most of the words.	

In an effort to win rapport with the group on this our first meeting, I posed my first 'focus group question' in the register most familiar to the learners. By turning the conversation to a discussion of Science learning, I was modelling how this register could be used to speak about Science topics. The learners surprised me by refuting that they could do this, despite exhibiting this exact skill during Science lessons that I had already observed. Phumeza is generous in offering to try this new way of communicating Science, but I unfortunately did not hear her suggestion. However, as began to be clear, the reason they did not attribute this Science talk in lessons to 'isiXhosa' was because of their definition of speaking Science in isiXhosa. For Khethiwe, at least, this indexed knowing the English scientific word equivalents in isiXhosa. Things became more complex when I shifted the focus from 'isiXhosa' to 'mixing', which was much more readily accepted as a viable register for 'talking Science'.

Extract 4.21: SG1. Science with a mix

Turn	Actor/Action	Speech	Gloss
1	Robyn:	Can you mix Science in... Can you speak Science with a mix? isiXhosa ngesingesi?	Can you mix Science in... Can you speak Science with a mix? isiXhosa and English?
2	Thandile	Mhm. Only explanations.	
3	Khethiwe	Ja.	
4	Thandile	I'm speaking isiXhosa.	
5	Robyn:	Only with the explanations?	
6	Thandile nods		
7	Robyn:	What's an explanation?	
8	Khethiwe	Like when you're explaining something.	
9	Robyn:	So what's not an explanation in Science? Give me an example of	

		when you're not explaining something in Science?	
10	Thandile	It's a statement, like saying something, saying something then you are confident, sure. But when I'm trying to explain to the whole class, like it gets difficult to explain it in English. So...	

Thandile holds that you can only speak Science with a mix for 'only explanations'. In order to explain what he meant he drew a distinction between an explanation which is 'trying to explain to the whole class' (ie exploratory talk) vs a 'statement' which is when you're confident and sure (presentational language). His use of 'only' as a preface for using a mix demonstrates its low status as a science activity – a widely held view where exploratory talk is under-valued as a learning device.

During the final study group meeting, I set the learners a translation task, the content of which will be discussed in Chapter 6. The task opened up conversations amongst the learners and myself about the registers being used to talk and write about Science. Three themes emerged from that discussion: some kinds of language we claim as our own ('claimed by the learners'); some kinds of language we disclaim ('disclaimed by the learners'), some kinds of language are 'useful for this exercise'. The names for registers which the learners used in the discussion have been listed in Table 4.5 below, categorised according to the theme they constituted.

Table 4.5: SG8. Registers in the translation exercise

Register	**Examples in the discourse**
Claimed by the learners	'kasi Xhosa', 'isitsotsi', 'isigingqi', 'isiXhosa', 'siya-mixa', 'Capetonian Xhosa', 'si-incorporata ubutsotsi' (we incorporate gangster-language)
Disclaimed by the learners	'deep Xhosa', 'deep isiZulu', 'formal Xhosa',
Used/useful for this exercise	'tsotsi taal', 'isiXhosa esidibene ne-English' (isiXhosa that is mixed with English), 'isiXhosa esivakalayo' (proper isiXhosa)

The variety of register descriptors used by the learners during the discussion implies the keen insight which they have into their own language use. They describe, creatively and clearly,

different registers in relation to how much they identify with them. The discussion also contained a fair amount of negotiation and conflict around the descriptions of the registers revealing the emotional investment learners had in accurately describing their language use. Ben Rampton, in response to the data he collected in secondary schools in London in the 1990s, posited the decomposition of the term 'native speaker' into the categories 'expertise' and 'allegiance' (Rampton, 1995, p.339). 'Allegiance' in turn was divided into varieties of language which a speaker felt an affiliation for and those which were part of her repertoire due to inheritance. Rampton's teenagers performed the same kinds of identity work as my Success High learners who 'disclaimed the inheritance' ascribed to them by outsiders. They distanced themselves from a particular kind of isiXhosa which they dubbed 'deep Xhosa' or 'formal Xhosa' and displayed an affiliation with urban vernaculars (Makoni, Makoni & Rosenberg, 2010) such as 'Capetonian Xhosa' and 'isitsotsi' (language of gangsters). Important too for this identity work is that all the references to the registers used by the learners were made using plural pronouns such as 'we', referencing a strong group identity constructed around language use.

Having explored attitudes to language use for learning displayed by the Principal, staff, Ms B and the learners of 9B, I now move into a discussion of the oral and written language practices both inside the learning spaces of the Success High classroom and in other interactional spaces in the school.

School language practices: oral

Outside the classroom

In the walkways and quadrangles of the school, teachers and learners interacted with each other in familiar registers. A close analysis of this talk was not conducted, but observations I made as I walked through the school yielded a sense of the easy camaraderie of school peers talking inside the school grounds as they would outside the school grounds. During the study group discussed above, I pushed the participants to find a term to define this familiar register that they use with each other. This was somewhat disingenuous of me as I would not be able to use one term to describe my most familiar spoken register as of course this is an idiolect and unique to me. However, the learners pressed on and used descriptors recorded in Table

4.5. This familiar register was also used between staff members, particularly among support staff, and when teachers speak one on one with learners. The teachers who shared this register with the learners used it in conversation with learners around the school. Even the Principal who purports not to speak isiXhosa, is able to understand learners when they speak within earshot of her.

Extract 4.22: Principal Interview. isiXhosa proficiencies

> P: when teachers when the kids converse with teachers outside of the classroom in most cases when it's a Xhosa speaking teacher they will converse in isiXhosa in most cases, right, when they speak to me they will sometimes because they so used to me, they will also start speaking in isiXhosa and (laughing) then they will check themselves (laughing) you don't understand (laughing) you know and they surprised sometimes when I actually answer (laughing) because I do
>
> Robyn: in Xhosa, or in English //oh you answer in English but you understood//
>
> P: // in English I answer in English but I //understood

The Principal laughs often in this section of her interview. She clearly enjoys recollecting moments of linguistic facility on her part and the rapport it builds with the learners. This mood is in contrast with her earlier serious comments about code-switching in the classroom. This suggests to me that debates around language in education for multilinguals are often rife with anxiety and the playful flexibility with which we use language everyday can be ignored and left out of discussions of appropriate language for learning.

I visited one school assembly where all members of staff and learners were invited. As was customary, a senior isiXhosa-speaking teacher led a devotion in isiXhosa and the Principal led the rest of the assembly in English. The use of isiXhosa in this setting was reported by a member of staff to be very much appreciated by the learners (personal communication, 210716). The assembly functions as a high-status domain and the use of isiXhosa in this space is symbolically powerful for the learners.

Moving from the social spaces outside of the classroom to the academic spaces inside the classroom brings a shift in language practices which vary according to the participants in specific classrooms.

Inside the classroom

Apart from the Natural Science lessons I joined with 9B, I shadowed the class in English, isiXhosa home language, Mathematics, Geography and Information Technology classes. The patterns of oral language use within lessons varied according to subject, classroom and teacher. Apart from Ms B, I observed five teachers teaching 9B. As Table 4.2 has revealed the teachers had varying linguistic repertoires which they used to interact with the learners. English dominated the plenary settings of each teacher, with the exception of isiXhosa home language in which isiXhosa was exclusive in the lesson I observed (fieldnotes 020316). Learners' language use was generally more heteroglossic than the teachers', although this was more pronounced during side-talk and conversations during seatwork.

School language practices: written

Outside the classroom

While the language policy is silent on environmental text in the school, a journey through the school to examine the language of public written text is illustrative of languages being used for specific purposes and audiences in a patterned way. In this section I will lead the reader on an imagined physical journey through the school premises pointing out texts which were on display in order to provide an analysis of hierarchies of language use in the domain of environmental text.

As a visitor enters the school, the first environmental text s/he encounters is the school motto printed large above the door leading from the reception area into the rest of the school buildings: 'No excuses – just success'. By referring to 'excuses', this motto positions itself in opposition to other schools, or learners, which may try to make excuses for their lack of success. It also emphasises its singular focus which is academic success. This message is voiced in English and oriented towards the visitor as it is the text appearing closest to the entrance.

The representation of the school in English is echoed by the vision which is pinned to a noticeboard in the lobby and aligns with 'success' in the motto by stating in the opening sentence that 'we…strive for excellence'.

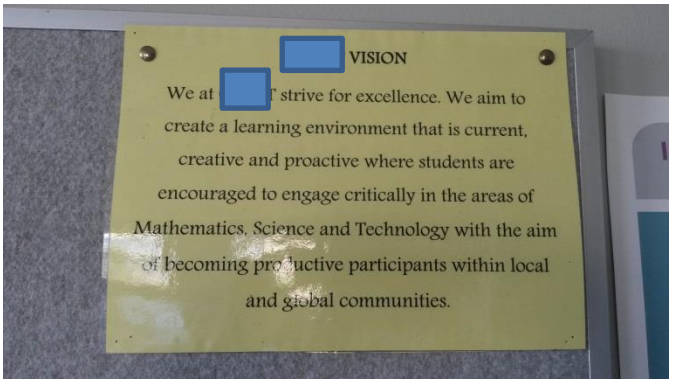


Figure 4.1: School vision displayed in the entrance lobby.

Appearing next to the school's vision are newspaper clippings of articles extolling the school as a fine example of a township school which is beating the odds and achieving success. As this is an area in which visitors wait, the audience can be assumed to be outsiders.

After leaving the formal printed text environment of the entrance lobby, one enters a space of buildings separated by paved thoroughfares and courtyards. There is a set of noticeboards outside the library with information regarding special learner groups and extra-murals, mostly printed with instructions in English.

Mid-way through the cluster of school buildings there is a brick wall which occasionally was used to tack messages and notices on to which were aimed at the learners. This was only visible if you were facing towards the exit of the school. The predominance of English in these texts was noticeable, with Figure 4.2, below being a typical example of a printed poster.

Figure 4.2: Bingo advertisement on the 'learner wall'

This notice with text in English has been word-processed. The English is remarkable because this is a poster produced by learners for learners. A phrase such as 'come through' is not one that learners would use with each other face to face when they would likely address one another in isiXhosa.

One hand-written note from a teacher was heteroglossic in its use of register, employing a convention from mobile phone text-messaging, '2MORO'. This orthography has the advantage of allowing the message to fit easily onto an A4 page and to be written quickly.

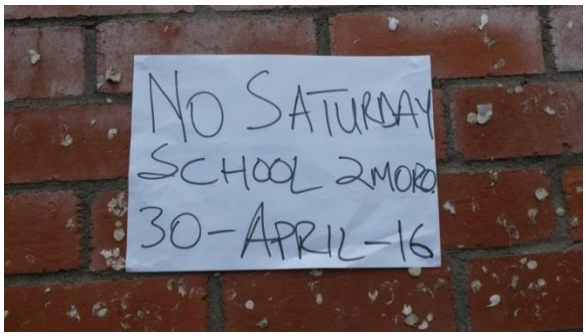


Figure 4.3: Notice about Saturday school on the 'learner wall'

Continuing on our return journey through the school, there is a notice written by the groundsman on a piece of used cardboard and it is found attached to a grill near a flowerbed (Figure 4.4). It employs translanguaging (García & Li Wei, 2014) in forming an instruction text aimed at learners in a familiar township register. Features associated with English and isiXhosa are drawn together into one heteroglossic text. Its purpose is to influence behaviour, and the groundsman has appealed to learners in a shared familiar register as a strategy of influence. In their linguistic landscape study of signs in Khayelitsha, Stroud and Mpendukana (2009) differentiated (following Bourdieu) between sites of luxury and sites of necessity and tracked how signage differed in these sites. I argue that the examples of signs at Success High reveal sites of luxury and of necessity operating within the school grounds. Stroud and Mpendukana argue that 'representations found in sites of necessity (are) highly contextualized in the immediacy of task-interaction' (2009, p. 373) and that they appear using materials which are non-durable, cheaper and usually found in the local environment. Stroud and Mpendukana found that the language use on signs in sites of necessity is usually heteroglossic with features of English and isiXhosa being used, while in sites of luxury there is more use of English and less mixing of linguistic features. All these features of sites of necessity apply to the sign in Figure 4.4, firmly placing the sign, its author and the activity of composting food waste in a site of necessity.

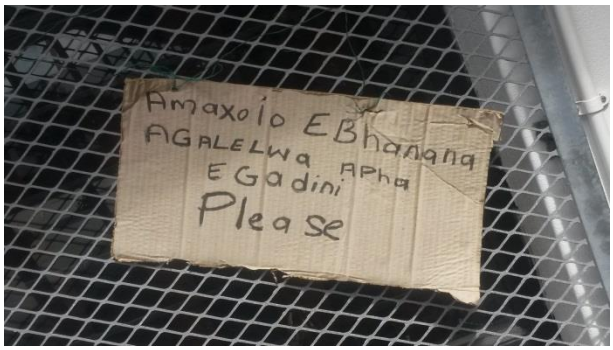


Figure 4.4: Banana peel sign

Translation: Banana peels must be thrown here in the garden, please.

We have now returned to the entrance lobby of the school – a site of luxury (Stroud & Mpendukana, 2009) positioned as it is near the offices of the school management. Just as we

walk out through the entrance doors to the school, there appears in large printed letters an exhortation: 'Fun'ulwazi – Be curious' (the English following the isiXhosa being a translation). Orientated as it is towards the school and learners as they exit the building, and written in both isiXhosa and English, I argue that this sign is intended for learners as a spur to be curious about the world they are entering as they leave the school premises. It is unique in featuring English and isiXhosa side-by-side with the English functioning as a translation of the isiXhosa. Its position at the exit of the school, only to be viewed on leaving, diminishes its impact as a sign in a site of luxury; however, it is significant in that it contains the only formally printed text containing isiXhosa to be found in the out-of-classroom premises of the school. This sign is typical of signage in sites of luxury in Khayelitsha, as argued by Stroud and Mpendukana, in that it employs highly edited English features as well as isiXhosa features which functions to link the present place (school) to other imagined places (university and the world of work).

The environmental text outside the classroom is self-reinforcing in that it expresses the values of the community but also upholds those values through its presence.

Inside the classroom

Academic learning spaces at Success High included: classrooms, computer laboratories, the library and the hall. I observed teaching and learning in four classrooms. Displayed writing in these classrooms was sparse and included subject-specific posters, motivational quotes and lists of names of learners. I found no examples of isiXhosa language and no examples of learners' work in classrooms. The library was the place where our study group was held and therefore another key learning space for the study. Apart from the scant availability of isiXhosa books in the library, there was also only one example of isiXhosa text displayed. After my first visit to the library, I made the following entry in my fieldnotes:

Extract 4.23 Fieldnotes 030216

> Interestingly, no displayed language appears in Xhosa, except the hand-written word 'amasiko' (rituals) on a sticker which has been stuck on a poster which advertises different career paths for different subjects. I ask the assistant librarian what 'amasiko' means and she tells me rituals but seems uncertain and so I point out the sticker and ask her if the word relates to the poster in any way. She says no and hastily removes the sticker. Is she embarrassed by its presence in the library? She says a child stuck it

> there. I wonder if she thinks I'm criticising its presence. Or perhaps she is just playing policeman to the transgressions of the children.

As I intimate in my fieldnote musings, the librarian censures the tacked-on hand-written text in isiXhosa. It may have offended her for other reasons than it's isiXhosa lexeme: it may have been unsightly to her, cluttering up the poster. However, I would argue that her hastiness in removing it without engaging with my interest in it reveals a sense of shame about it with me, a white English-speaker, as its audience which is deeper than its perceived untidiness. It was not the only time I experienced a pro-English sheen being applied to the cultural life of the school in my presence. On the 14th of April, I photographed a poster including pictures of nine authors which had been displayed in the library. My reason for taking the photograph was that I was startled that all nine authors were white. This concerned me as I wondered if the learners would interpret this as an indication that to be an author you need to be white.

In sum, English language text in the environment of the school is given prominence, by its appearance on more durable materials and printing resources being allocated to it, while isiXhosa is displayed using make-shift materials and is not as prevalent, with the exception being the printed bilingual text: 'Fun'ulwazi – be curious', although this is placed at the exit to the school which makes it peripheral rather than central to the printed discourse of the school. The language hierarchy in written text on school grounds contributes to the under-valuing of isiXhosa in the school community.

Conclusion

The story of the language environment of the school is one of constraints, diversity and homogeneity, contradictions and manoeuvring. The school language policy reveals a strong Anglonormative ideology (McKinney, 2017) and is brief, without offering much guidance to teachers about how to use language for learning in their multilingual classrooms. This results in a diversity of responses by staff and sets up practices in classrooms where the language use of teachers and learners often diverges quite dramatically from the policy, as is typical in many South African classrooms (Probyn et al., 2002, Probyn, 2009). Standardised assessments and university aspirations cast a long shadow on attitudes and beliefs about language use at

school. A virtual tour of the linguistic landscape (Stroud & Mpendukana, 2009) of the school both inside and outside the classroom revealed a hierarchy of languages found in displayed text in favour of English, with a fair amount of heteroglossic (Bakhtin, 1981) language use displayed in less-visible texts.

I have surveyed a wide range of data in this chapter including: language policy, written language in the school environment, fieldnotes, recorded go-alongs, interactional data and interview transcripts. This variety of data sources reveals how the complex and constrained language-ideological environment of Success High is constructed explicitly through metalinguistic talk and writing; in material ways through objects in the environment and discursively through the language use members of the community.

Chapter 5 which follows is the first of the three data analysis chapters which depend upon the interactional data recorded in the two learning sites of the classroom and the study group for their core arguments.

5 Constrained meaning-making

> *Development of literacy within any subject in the school curriculum involves learning to control the registers – the specific technical language and grammatical patterns – and generic structures particular to that subject.*
>
> - Gibbons, 2006, p.4

Introduction

In the following three chapters I will build a theory of three types of meaning-making which will describe the learner practices found in my case study. As outlined in Chapter 2, I will argue that the meaning-making in the class lessons and study groups is comprised of *constrained*, *guided* and *spontaneous* meaning-making which produce different patterns of discourse; evoke different identity positions and ultimately construct different types of science meaning.

Constrained meaning-making is constrained in terms of topic, register and discourse structure. Topics studied are aligned with the teacher's interest, which is in turn circumscribed by the demands of the curriculum and assessment requirements. Learners in particular need to conform to a register of science language which is narrowly defined in constrained meaning-making. The discourse structure is also constrained with turn-taking circumscribed and shorter learner texts predominating and fewer opportunities for learners to practise the discourse required by standardised assessments and/or the scientific community.

Guided meaning-making occurs in activities set up by the teacher or facilitator, but in which learners are encouraged to find their own path to meaning and express this meaning flexibly (Lemke, 1990), varying the register as the situation demands. The discourse structure is more flexible than in constrained meaning-making and there is also flexibility for learners to direct their learning to focus on a particular aspect of the topic.

Spontaneous meaning-making happens when learners engage with the topic with no intervention or direct stimulus provided by the teacher or facilitator. Here learners generate

meaning spontaneously, and often playfully, drawing on any aspect of their semiotic repertoires in pursuit of their own interests.

The three types of meaning-making which I will posit are not discrete, but overlap, bleed and morph into one another within one learning activity. Hence, in some instances the same data may be used to explicate more than one kind of meaning-making; or one learning activity will appear in more than one chapter. However, this complexity does not foreclose the different types being identified and analysed separately in order to argue that they produce different kinds of science meaning. Meaning-making captured during the course of the topic which focuses on other science or lifeworld topics is not discussed in these chapters.

Before describing the mechanics of *constrained meaning-making* I will outline the first constraint upon the learners' Science meaning-making: the curriculum topic under study.

The topic

The Natural Science topic 'Chemical reactions' was studied by Grade 9B at Success High over four weeks during which the interactional and textual data was collected. In this next section, I will sketch the extent of this topic as it was realised in the data. The data which I draw upon here is the entextualisation of the topic in planning documents, namely: Ms B's term plan for Grade 9; the Grade 9 Natural Science curriculum; the textbook unit headings; and the test. In addition to these planning documents, I created a summary of the topic as I conceived of it as a learner. This summary is supplied in an informal thematic diagram (Lemke, 1990) included as Figure 5.1.

The topic entextualised in planning texts and the textbook

The first Natural Science topic studied in Term 2 in Grade 9 at Success High is 'Compounds and Chemical Reactions'. Its theoretical foundation is the particle model of matter. It forms part of a term-long chemistry unit called 'Matter and materials' and is the first of four topics in this unit. The three subsequent topics all include practical work on testing for acids and bases and on different kinds of chemical reactions involving metals and non-metals. This first topic therefore forms the theoretical basis for the practical work which comes later. While

other topics in Natural Science focused on processes with more links to learners' lifeworld experiences (Gee, 2004), the chemical processes of this topic were approached in an abstract way. This first topic was concluded by the summative test.

The topic of study was outlined in three written iterations in my data set: Ms B's term plan for Grade 9; the Grade 9 Natural Science curriculum[35]; and the textbook unit headings. Then the topic was made manifest in the discourse of ten 60-minute lessons undertaken by Ms B, myself and the 36 learners of Grade 9B. Table 5.1 compares the time allocated to sub-topics in three iterations of the topic: the CAPS document; the teacher's plan and the actual lessons. Included are the marks allocated to each sub-topic in the test.

Table 5.1: Weighting of sub-topics (number of lessons and marks) in the topic 'Compounds and chemical reactions'

Sub-topics	**CAPS document and Ms B's plan**	**Actual lessons**	**Summative test**
1 The periodic table, names of compounds	3 lessons (50%)	4 lessons (42%)	25 marks (83%)
2 Chemical equations to represent reactions, balanced equations	3 lessons (50%)	5.5 lessons (58%)	5 marks (17%)
Total	6 lessons	9.5 lessons	30 marks

The table demonstrates that the curriculum (CAPS document) is highly prescriptive of content and pace, indicating exactly how many lessons should be spent on each sub-topic. Ms B's plan follows this time allocation exactly, but the time spent in the actual lessons is greater than the allocated time in the curriculum. The lesson time includes the writing of the summative test and 'going over' the test, during which much content teaching happened. The summative test allocated 83% of the marks to the first two sub-topics: the Periodic Table and Names of Compounds, although only 42% of class time was dedicated to studying these sub-topics. The largest portion of class time was spent studying the third and fourth sub-topics: 'Chemical

[35] https://www.education.gov.za/Curriculum/CurriculumAssessmentPolicyStatements(CAPS)/CAPSSenior.aspx

equations to represent reactions' and 'Balanced equations'. The formal assessment of this learning was given only 17% of the mark allocation. This reveals a mismatch between what Leach (1999) terms the learning and teaching demand (as cited in Mortimer & Scott, 2003) of the sub-topics and the assessment practices.

The study group[36] was set up to be responsive to learners' questions and problems about the topic as a whole and new topics which surfaced. I initiated the study group and was given free reign by the Principal to conduct any activities I planned. I made no written plan prior to the first study group meeting. As the sessions progressed, I began to make written plans for the activities I wanted to lead the learners through. These, however, were very loose and so are not included in Table 5.1.

The textbook - Platinum Natural Sciences: Learner's Book 9 by Bester et al. (2013) - is endorsed by the National Department of Basic Education as a curriculum-compliant textbook and widely used in many Western Cape schools. It does not allocate time guidelines to the study of topics or sub-topics, but also forms an important part of the conceptualisation of the topic, both by the teacher and the learners. The textbook was the only resource book used in class lessons and by the learners when preparing for the test. The unit headings in the textbook, the curriculum sub-topics and Ms B's plan were exactly the same.

Table 5.1 illustrates that in the 9B classes, we spent time in excess of that allocated in the curriculum documents and Ms B's plan on the topic. By the end of the term, Ms B reported that she was happy that she had covered the set curriculum for the broader topic, 'Matter and Materials' (Teacher Interview 2). This reveals that the majority of the lesson time within the broader Chemistry topic was spent on the theoretical topic, 'Chemical reactions'.

The topic as an informal thematic diagram

The diagram below (Figure 5.1) represents a point in my own meaning-making processes as I have come to understand the scope of the topic. What it offers is an overview of what Lemke (1990) calls the semantic relations (named in brackets and linked by arrows) between thematic units which comprise the topic. Using Lemke's informal thematic diagrams as a

[36] Further details about the practices of the study group will be given in Chapter 6.

guide, I drew up this diagram which demonstrates how key thematic units (here realised as one- or two-word terms) are linked in a web of meaning comprising the topic and extending beyond it. The thematic units and sub-units were selected based upon my study of the topic at Grade 9 level. This diagram was checked for conceptual accuracy by a colleague working in Science education who is well acquainted with the Grade 9 curriculum (Rene Toerien, personal communication).

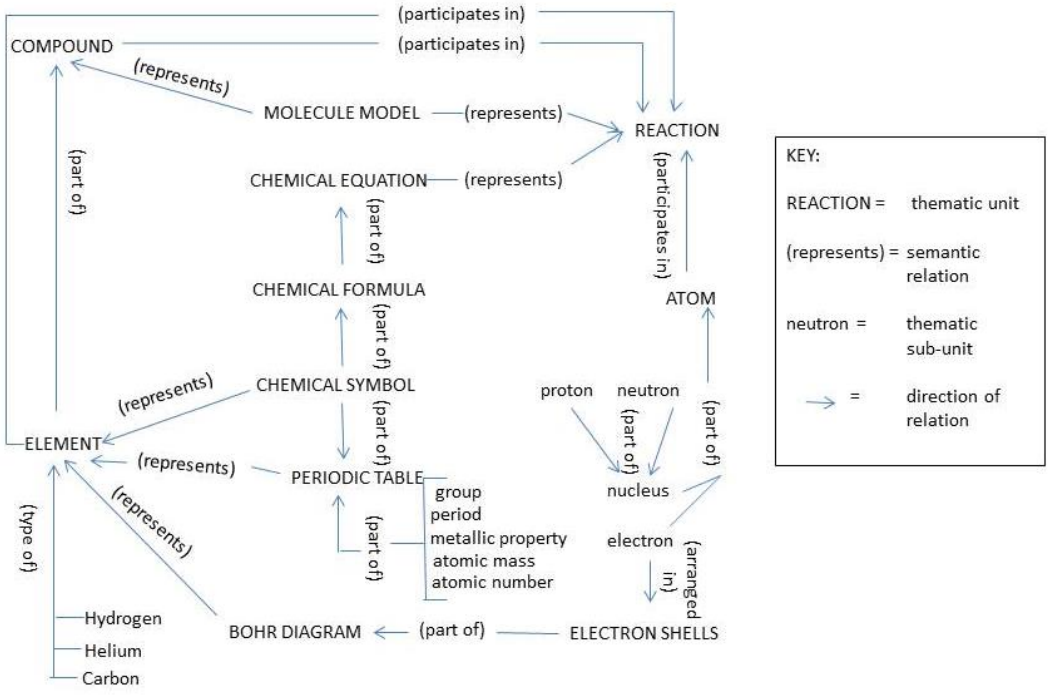


Figure 5.1: My informal thematic diagram of the semantic relations between thematic units of the topic 'Chemical Reactions'

While the thematic units and the semantic relations between them are entextualised in the diagram using verbal English language, their expression in the classroom discourse, textbook, test and boardwork occurred in a variety of modes. I do not claim to present a comprehensive list of semiotic modes, but suggest the following as an open-ended list in my analysis of the meaning-making practices of the classroom and study group: colour (in the Periodic Table and molecule models); mathematical symbols (in chemical equations and chemical formulae); gestures; drawings (Bohr diagrams, molecule models); and verbal language (spoken and written). Manipulation of objects was suggested in a textbook activity (Bester, 2013, p.83).

Learners were required to use playdough to make 3D models of compounds. This activity was undertaken in the study group but not in the classes.

The informal thematic diagram in Figure 5.1 will be drawn upon later in this chapter when one semantic relation is isolated for analysis of the learners' meaning-making practices as they constructed it discursively in the classroom discourse and the test.

Having given an overview of the topic as a whole, I now move on to introducing constrained meaning-making and analysing examples of constrained meaning-making in the data.

Constrained meaning-making

Classrooms are learning spaces that are constrained at many levels. Teachers and learners are constrained by the curriculum and assessments which means that they must engage with particular content in a particular sequence. Discourse is constrained by the differences between the learners and the teacher in both knowledge of the curriculum and in their social position. Physical space is constrained and human resources are constrained. The timetable limits teaching time. Codes of conduct, language policies and reporting demands by subject advisors from the WCED constrain what can be done and said. The registers available to learners for use in meaning-making may be restricted by teachers' ideological position on the usefulness or appropriateness of the register in the classroom, as well as of course by the language policy of the school[37]. These restrictions all work together to produce the most dominant kind of meaning-making found in the 9B Natural Science classroom: constrained meaning-making. The study group was informed by the same curriculum, inequality in knowledge of that curriculum between myself and the learners (although this was smaller than between the teacher and the learners) and the limits of time. It was not, however, constrained by any language policy or by the surveillance of colleagues or subject advisors. Thus, while constrained meaning-making practices were found in both settings, they were more prevalent in the class lessons.

[37] Register restrictions described in interviews and the language policy of Success High were discussed in Chapter 4.

Meaning-making in school Science classrooms has historically been highly controlled and dominated by the teacher. Controlled meaning-making aligns closely with Mortimer and Scott's notion of the authoritative communicative approach (Mortimer & Scott, 2003) in which 'attention is focused on just one point of view, only one voice is heard and there is no exploration of different ideas' (2003, p.34). The single point of view referred to by Mortimer and Scott is that of 'school Science', a particular version of the scientific story about the topic under study which is sometimes at odds with the view of the scientific community at large. In constrained meaning-making, classroom activities are planned by the teacher and there are well-known ground rules (Mercer, 1995) for engagement in the discourse. Learners have little choice in how they may respond to initiations made by the teacher, unless they are willing to radically flout the ground rules of the dominant discourse. Also, meaning-making is constrained in terms of mode and register choice. The teacher or facilitator defines the mode of communication and this is often restricted to the oral or written modes.

In Natural Science, the register required of the learners is usually a version of scientific English, although the teacher may be more varied in the registers s/he uses. These register requirements can also be viewed as ground rules, in that the learners and the teacher are expected to use particular registers in class and surprise or humour is likely to ensue if these rules are broken. The register rules are learned through censure and praise of learners by the teacher and fellow learners. The consequence of this kind of meaning-making is that the knowledge under study is narrowly defined (Shohamy, 2004) for the purposes of assessment. Constrained meaning-making is useful for allowing teachers to feel confident that they have 'covered the curriculum'. Knowledge is presented as settled and held by a narrow set of authorities, usually just the teacher and the textbook. In this kind of meaning-making one often hears traces of the looming assessment in the discourse, reminding learners of 'what counts as knowing' (Hicks, 2003, p.11) at any particular time. The example below of Khethiwe's interaction with Ms B is illustrative:

Extract 5.1: C6. Khethiwe and Ms B

Turn	Actor/Action	Speech	Gloss
1	Khethiwe	Miss ayizophuma yonke le nto siyenzayo kula test?	Miss, will all of this that we are doing come out in that test?

2	Ms B	Izophuma. The test is only on Friday next week.	It will come out. The test is only on Friday next week.

Ms B uncharacteristically responds to the learner's initiation in isiXhosa at first, perhaps empathising with Khethiwe's anxiety about the upcoming assessment. Then, in her use of 'only' she frames Khethiwe's question as overly anxious. However, Khethiwe's concern is well founded in that the test results will be reported to parents and eventually will have an impact on progression to the next grade.

Learning environments in which there are multiple participants, such as classrooms, can form more than one communication channel. Goffman (1981) recognises a dominant communication channel and subordinate communication channels in these settings. In classrooms one of the common ground rules for discourse is that the teacher sets the dominant communication channel. Subordinate channels are those which are opened between learners or in private conversation between a learner and the teacher. So, as I discuss instances of constrained meaning-making here, I note that subordinate channels of communication including the other two types of meaning-making - spontaneous and guided - can be operating concurrently with the dominant, constrained channels. Importantly though, these channels are usually either not available to, or are ignored by, the teacher and so are often not brought into the dominant channel and therefore the awareness of the teacher. Also, I will show how the learners' meaning-making is both compliant with the dominant discourse of the teacher or facilitator and resists it on different occasions, demonstrating their agency in the teaching and learning endeavour.

In order to describe the forms and meaning implications of constrained meaning-making in my case, I draw on Lemke's (1990) activity types. Activity types are brought into being through particular discourse patterns and participant roles. In the oral-dominated activities such as 'teacher exposition/review' and 'go over' (Lemke, 1990, p.217), monologue and Initiation-Response-Evaluation (IRE) discourse (Sinclair & Coulthard, 1975) are prevalent. In the writing-dominated activities such as 'seatwork' (Ibid.) involving working through textbook exercises, learners respond in brief to written instructions in prose given by the authority represented by the textbook writers. The main activity types which occurred in the dominant

communication channel of the classroom are presented in Figure 5.2 along with the amount of topic-specific time each comprised.

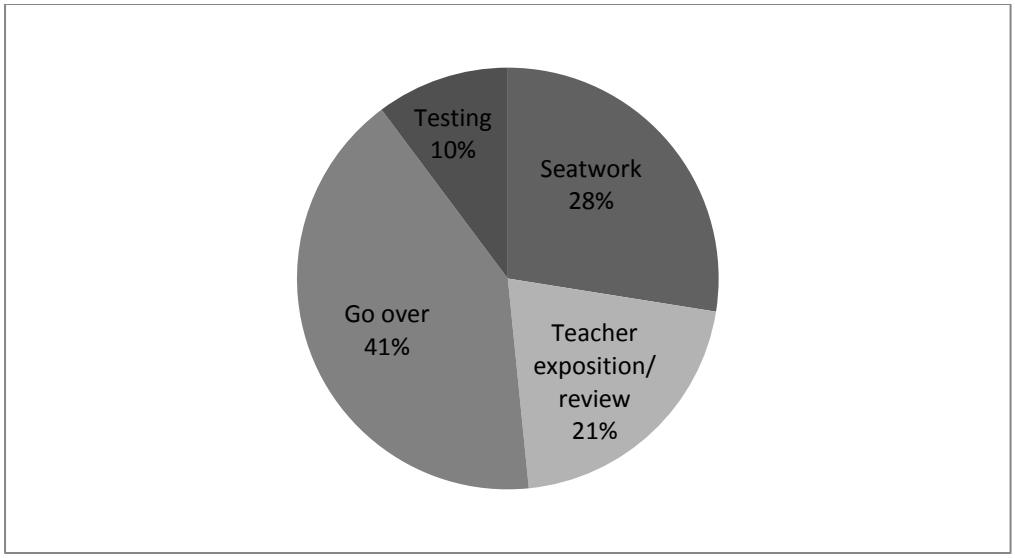


Figure 5.2: Main activity types in the dominant communication channel of the class lessons group as a percentage of total topic-specific time.

Figure 5.2 reveals that the dominant activity type was 'go over' (41%) – an activity in which the teacher leads the class through the answers to a written activity usually employing the three-part structure of initiation-response-evaluation, with the initiation comprising the written question which were read aloud. The second most frequent activity was 'seatwork' (28%) where learners completed written exercises in their notebooks, usually accompanied by talk with their seat mates. 'Teacher exposition or review' (21%) involves the exposition of new or previously taught content, usually employing IRE discourse. 'Testing' (10%) is similar to seatwork but it is completed individually and assessed formally by the teacher.

Oral-dominated plenary activities

Teacher exposition and teacher review are ubiquitous activities in Science classrooms (Lemke, 1990). The Success High classroom and study group were no exception. In these activity types, the teacher may present new information, or review previously presented information in different ways, sometimes through reviewing seatwork. The teacher selects material to be presented and leads his/her learners through it either in monologue form or in IRE discourse (Sinclair & Coulthard, 1975; Lin, 2007). These activity structures allow the teacher maximum

control over the discourse as the pattern is well known to all participants. According to Mortimer and Scott (2003) this amounts to an 'authoritative communicative approach' in which:

> attention is focused on just one point of view, only one voice is heard and there is no exploration of different ideas (2003, p.34).

In these oral-dominated activities in the 9B classroom, Ms B usually responded only to the oral mode of meaning-making. Learners were seated at tables facing the teacher and sometimes contributed in action modes, but this went unremarked. Ms B stood at the front of the classroom and moved around, gesturing while she talked. The oral discourse took the forms of a monologue or triadic discourse. In the study group, teacher exposition and review were less dominant activities.

Monologue forms

Following Bakhtin (1981) and Goffman (1981), I allow that even a monologue is dialogic in nature, with the animator of the message (the person who produces the discourse) receiving communication signals from his/her audience. For my purposes here, I define monologue loosely as a discourse structure in which one animator holds the floor without eliciting responses from the receptors. In the classroom monologue, the ideal learner's role is, at the very least, that of silent receptor (Goffman, 1981), although they may make back-channelling minimal responses or, less often, contribute by interrupting to ask a question or make a comment. Hence, this is a very constrained type of meaning-making, dominated in turn number and turn length by the teacher or facilitator, who is in turn constrained by the curriculum and assessment. Extract 5.2, below, is a typical example of a facilitator review in monologue form.

Extract 5.2: SG7. Facilitator monologue (transcript from audio, no video)

Turn	Actor/ Action	Speech
1	Robyn	So we already worked out that atoms is the absolutely the smallest smallest smallest thing

2	Khethiwe	Hm
3	Robyn	Um of a substance smallest unit is better than thing ok the smallest unit of a substance
4	Khethiwe	M hm
5	Robyn	Ok is an atom that's the absolute smallest except that we then went into sub-atomic and <FAST> we found that they were electrons and neutrons and protons </FAST> didn't $_{we}$ <FAST> we discovered that there was something even smaller than an atom</FAST>
6	Phumeza	//yes//
7	Khethiwe	//woah//
8	Robyn	These little things that make up the atom

In the study group session from which this extract was taken there were ten participants. In my role as facilitator, I performed a monologic review of the composition of atoms while Phumeza and Khethiwe offered back-channelled commentary and the others were silent. My monologue was sustained by discourse markers such as 'so' (Turn 1) and 'ok' (Turn 3 and 5) which indicate to the other participants that I had not finished my turn yet. I presented monologic explanations such as this from time to time and the learners fulfilled their roles of interested listeners dutifully (and hopefully genuinely), demonstrating explicit interest at times (Turn 7). Also of relevance to constrained meaning-making in this extract is to note that my oral language forms a meshed register: scientific terms ('atom', 'sub-atomic') are used alongside everyday, tautological ('absolute smallest', 'smallest, smallest thing') and non-standard grammar ('atoms is') associated with colloquial speech. My register does not model 'pure Science' (Lemke, 1990, p.173) but rather draws together language with which learners are already familiar and the scientific register.

In a monologue, the teacher relies on thematic development strategies (Lemke, 1990) to aid learning. While the learner is in the receptor role, the teacher can provide powerful contexts for learning by the strategies s/he employs. In Extract 5.2 above, I used strategies called glossing and tone concord to provide local equivalence for the terms 'smallest thing', 'smallest unit' and 'atom'. Glossing is the use of a variety of lexemes in close temporal proximity, hence showing their equivalence (Lemke, 1990, p.111). The three phrases appear very close to each other in Turns 1 and 3 in the extract. Tone concord is the use of a similar tone for each of the

lexemes (1990, ibid.). I drop my tone for each of the lexemes in the extract thereby connecting them through tone. While in this example I am speaking a variety of English only, these thematic development strategies are often expressed in multilingual contexts through pedagogical translanguaging (Probyn, 2015), or the use of different features of the multilinguals' repertoire in order to make a new concept meaningful. In a similar way in Probyn's study, Teacher B, also an isiXhosa-English bilingual, uses glossing and tone concord to provide local equivalence for the terms: 'iyazitsala', 'attracts','iyayiattracta' (Probyn, 2015, p.231).

While the dominant authors (Goffman, 1981) of the topic were the teacher, the facilitator and the textbook, there were a few occasions when other authors and authorities were deferred to for exposition or review of the topic content. This inclusion of 'more than one point of view, more than one voice' is described by Mortimer and Scott as a 'dialogic communication approach' (2003, p. 33). Activities which introduced other voices were the playing of a video and reading from a non-prescribed text, such as a reference book or a webpage. These other texts were only used during the study group. They were:

1. The New Periodic Table song – Youtube video (Moffit, 2015)
2. Water molecules – Part 1 – Youtube video (Canadian Museum of Science, 2011)
3. How can you see an atom? – Youtube video (Kean, 2015)
4. Chemicals in Action: Elements and Compounds (Oxlade, 2002)
5. Usborne Introduction to Chemistry (Chisholm & Johnson, 1983)
6. The Young Oxford Library of Science: Atoms and Elements (Bradley & Crofton, 2002)
7. Thing Explainer: Complicated stuff in simple words (Munroe, 2015)

These texts offered presentations of the topic by authors unknown to the learners. Learners were more comfortable critiquing and questioning these authors than the familiar teacher or facilitator. The text of a reference book can be interrogated without concern for its feelings. These texts can generate side-talk (Lemke, 1990) – talk between learners concurrent with the talk in the dominant communication channel - or engagement with peers or the teacher as will be shown in Chapter 7. Learners can also discover new avenues of inquiry when given a text which concerns different parts of the topic and even different topics to the one under

inquiry. When viewing a video or reading from a reference book, the learners were recipients of a monologue, although it was in a different mode to the usual classroom monologue in spoken form.

Constrained IRE forms

In the class lessons and study group sessions there were few moments of exposition through monologue and they were short-lived. The dominant structure for exposition and review was triadic, or IRE, discourse. In this discourse structure, learners have clearly cued response slots to fill, which the teacher then explicitly or implicitly evaluates. The cues for a required response are well understood by all participants: the teacher poses a question (such as in Extract 5.3), or perhaps requests a filler response through rising intonation. An example of triadic discourse is drawn from the first lesson in the topic where the teacher is reviewing the prior knowledge of the Periodic Table with the learners.

Extract 5.3: C1. Teacher triadic review

Turn	Actor/Action	Speech
1 Initiation	Ms B stands at board where Periodic Table is displayed and points to Periodic Table while gaze is towards class:	what do we call the elements in this group in the last group group 18
2 Response	Mthobeli raises hand Ms B points to Mthobeli with ruler Mthobeli:	 Noble gases.
3 Evaluation Initiation	Ms B smiling: Ms B gaze to Mbulelo	The noble gases, yes what does that mean Mbulelo what are noble gases
4 Response	Mbulelo:	Eh, misi eh, <SLOW>they are called noble gases because <SLOW> . they are not very reactive.
5 Evaluation	Ms B nods:	Yes, they are not very reactive.

This is an example of the most constrained variety of IRE discourse in the data set. The three moves of the IRE discourse are very clear and turns are taken predictably by the teacher and

the learners. This is aided by ground rules for classroom talk (Mercer, 1995) such as learners raising their hands if they are offering a response; rising intonation from the teacher acting as a cue to learners to offer a response; and the teacher selecting learners by name for response turns. The register used in these responses was typical for learners' responses to the teacher's initiations and constitute register ground rules: Turn 2 and 4 are uttered using a formal scientific English register. Learners' turns tend to be few and short, guaranteed by the use of closed questions, and they are rarely engaged in exploratory talk (Barnes, 1992) through the teacher's initiations. This can be an effective way of ensuring learner participation especially where learners are emergent bilinguals, still learning the named language of which scientific English is a variety. However, the disadvantage of this tight IRE structure is that learners are more likely to adhere to 'fixed words' (Lemke, 1990, p.91) as these can be memorised (McKinney et al., 2015). As learners' responses are expected to be presentational in nature, there is a risk that conceptual depth may be sacrificed and misunderstanding masked. In a South African study of classroom talk in a rural isiZulu-speaking setting, the teacher and the learners performed what Chick called 'safe-talk' – a routinized form of IRE in English in which the lack learning was masked by the fixed wordings being chorused (Chick, 1996). The example of the adjective 'reactive' (Turn 4) in this extract is a case in point. Later on in the lesson series (C7) Thandile reveals in discussion in his group that he is confusing 'reactive' with 'radioactive', an indication that the meaning of 'reactive' here has not been sufficiently determined.

Extract 5.4 C7. Thandile confuses 'radioactive' and 'reactive':

Turn	Actor/Action	Speech
1	Mtho:	It is radioactive.
2	Thandile	Redi^{active} re^{active}

The example in Extract 5.3, above, shows a triadic structure in which there is a smooth movement between the three parts: initiation, response and evaluation. This occurs when learners are relatively sure that their responses are correct and the teacher accepts the response without contesting it. I will now present an extract where the learner's response is hesitant and eventually incorrect. The learners' meaning trajectory in these instances

depends very much on how the teacher scaffolds, probes and follows up during the evaluation move.

Extract 5.5: C1. Incorrect learner response

Turn	Actor/Action	Speech
1 Initiation	Ms B: Both hands open with fingers splayed at chest height Ms B: shifts gaze from Mthobeli to other side of class briefly. Eyes widen, head tilts down, gaze to Mthobeli Ms B:	Where What do we find in the nucleus [All] of it
2 Response	Ls:	No, Miss
3 Initiation	Ms B: Both hands hold the ruler (Ms B stands still for duration of Mthobeli's next Turn)	What do we find
4 Response Evaluation Response	Mthobeli: Fingers of right hand come together at tips. Fingers separate and hand makes a swift movement to the right Ms B: nods head Mthobeli:	Em. We. 6 we find protons and electrons (Ls: indistinct) <FAST>Protons<FAST> are moving outside the
5 Initiation (probe)	Ms B:	Outside [the]
6 Response	Mthobeli:	(Indistinct) negative and the electrons are moving inside the (indistinct)

Mthobeli's response in Turn 6 is incorrect in that, although he may not have provided the term 'nucleus', he has intimated that electrons are found inside this atomic structure. In considering how Mthobeli's meaning-making is constrained here, I will focus on the actional modes employed both by Ms B and Mthobeli. During IRE discussion such as this, the teacher has more physical room to employ actional modes as her body is unconstrained by furniture in contrast to the learners who are seated at desks. In this instance Ms B employed gesture,

facial expression and gaze to select Mthobeli as respondent (Turn 1), affirm his speaking rights (Turn 3) and evaluate his response (Turn 4). Although constrained by furniture, Mthobeli was free to use his hands and he employed them in making meaning even while his speech falters. His gestures in Turn 4 preceded his speech and captured the meaning of his words which followed (Roth, 2004). He had a critical audience and adjusted his responses according to their back-channeling. Also, he did not associate the sub-atomic particles correctly with their place in the atom; however, he distinguished, through gesture and speech, between the nucleus and particles moving outside the nucleus. Ms B did not draw attention to his gestures and did not extend the meaning trajectory from these gestures to the oral scientific register. Thus, the exploratory meaning-making of the learner was not valourised and he was not required to link these exploratory gestures to the high status and demanding scientific register in English.

In the study group, IRE discourse was less formal and more unstructured – at times even chaotic - but nevertheless were constrained in important ways. The example drawn from the study group (Extract 5.6, below) includes two responses from learners to the question by me, followed by my feedback on Khethiwe's response.

Extract 5.6: SG7. Facilitator triadic exposition (only audio available)

Turn	**Actor/ Action**	**Speech**
1 Initiation	Robyn	So can you ever have a compound that's made up of one atom
2 Response	Asanda	So you add (indistinct) (R: a single one)
3 Response and elaboration	Khethiwe	No that's an element (Ls: indistinct)
4 Evaluation with elaboration	Robyn	No because it has to be two different kinds a yellow one and a red one

In this example we see the constrained meaning-making being stretched somewhat by Khethiwe who offered not only the correct response to my question, but began to elaborate by contrasting compounds and elements in terms of composition (Turn 3). As is typical in constrained meaning-making this elaboration move did not gain traction as I moved quickly into the feedback (evaluation and elaboration) move of the triad (Turn 4), adhering to my initiated script. However, I argue that the more informal context of the study group enabled the kind of elaborated responses by learners that Khethiwe gave in a way that the class lessons did not. This is probably due to a more convivial social environment (as argued in Chapter 3).

One of the activity types used by the teacher to provide exposition of content is what Lemke (1990, p.217) calls 'going over seatwork'. After a seatwork activity (usually done in writing) has been brought to a close, the teacher initiates an activity where the written answers of the learners are reviewed through a whole class discussion – a traditional teacher-led practice as detailed by Lin (2007). Figure 5.2 reveals that this activity type dominated the class lessons in terms of time, taking 41% of topic-specific teaching and learning time. By going over work, the teacher can develop ideal answers in relation to the topic and these can be queried or developed by either the teacher or learners. Also, the written questions offer a pre-determined script which would provide some security for an inexperienced teacher such as Ms B. This activity type often takes the structure of IRE in which the teacher or a learner reads out the written instruction from the worksheet, test or textbook, a nominated learner responds with her version of the answer, and the teacher evaluates and gives feedback on this response. If the response is deemed incorrect by the teacher, s/he may call upon another learner to give an alternate answer.

Going over seatwork was an activity which was often disrupted by learner challenges to the ratified answers. This would then be followed by another period of exposition of a particular concept by the teacher. Indeed, much of the exposition of the concepts happened in this way as part of the 'going over seatwork'. The teacher often employed the use of trans-semiotising (Lin, 2015), or shifting between modes, during 'going over seatwork' to achieve thematic development. If the seatwork answer required was a chemical equation, she would re-package the answer through drawing a Bohr diagram on the board – like that in Extract 5.11. Learners thus had an alternative expression of the same meaning, often one which allowed

more detail to be added – fulfilling a 'why?' question from learners. The meaning being transformed from the written symbolic mode into the diagrammatic visual mode enabled understanding.

IRE forms can give way to more dialogic forms of talk during which learners take longer turns and produce extended discourse which is often exploratory in nature. This happened in both the study group and the classes, usually as a result of an open question by the teacher/facilitator or by an interruption of the flow of the IRE by a learner question. Unsolicited learner questions are a feature of spontaneous meaning-making which will be discussed in Chapter 7.

Figure 5.2 demonstrates that IRE forms of meaning-making – teacher exposition/review and going over seatwork - dominated class time. The implications of IRE dominating class time are threefold. Firstly, due to the dominance of teacher talk in the IRE structure (Sinclair & Coulthard, 1975), the main model of Science language for the learner is the teacher's talk. This means that the efficacy of class time used for learning this language depends on the quality of the teacher's talk. Lin (2016) points out that teachers in multilingual settings need to model the scientific register coherently and use metadiscourse frequently to scaffold the acquisition of the scientific register. Another factor influencing quality of teacher-talk is the thematic development strategies used by the teacher. Gibbons (2006, p.55) argues for 'message abundancy' which amounts to a variety of thematic development strategies being used by a teacher in order to make multiple pathways to meaning open to her learners. Secondly, the participant who makes the initiations controls the topic of the discourse, unless another participant interrupts to initiate a new topic, which is rare in classrooms. In strict IRE discourse, the teacher is the only participant making initiations and hence his/her interest is foregrounded, limiting opportunities for learner appropriation of the discourse. Thirdly, as has already been touched on, this kind of oral meaning-making is rather more constrained for learners than for teachers (Lin, 2016). Learners are expected to produce presentational language (Barnes, 1992) in a scientific register. Teachers, who are assumed to have greater command of the scientific register by virtue of their greater education, at times use a more social, or meshed register. This is possibly a real attempt to bring the topic under study closer to the learners, by employing a register with which they are more familiar. Also, the oral mode of communication facilitates and conventionalises these social and meshed registers. The

consequence, however, is that the learners can suffer due to a lack of a model of presentational discourse in the scientific register. Furthermore, as genre theorists in education have pointed out (Christie, 1995), the semantic relations between thematic items (Lemke, 1990) may be drawn out through thematic development strategies, but the stylistics of presentational language, even if this language exists in texts in the class, may not be explicated through metalanguage. For example, a teacher may read a sentence from a text which contains a nominalisation and then gloss the nominalisation using a more familiar register without pointing out the equivalence of the familiar phrase and the nominalisation or allowing the learners to practice the nominalisation themselves.

Constrained meaning-making through IRE discussion presents the possibility of opting out as well as resistance. Like in all classrooms, some learners at times opted out of making meaning within the Science topic through siding (in speech, gesture, writing or reading) about other things (Lemke, 1990, p.75). At times 9B learners also resisted the strictures of constrained meaning-making spontaneously. These occasions are described in Chapter 7.

Writing-dominated activities

Seatwork activities vary greatly in the kinds of meaning-making they produce both in the active phase and in the 'going over' phase. So, in terms of constrained meaning-making, I select the seatwork activities which constrained learners' responses and seatwork which constituted formal, individual testing. Written questions in seatwork activities such as this were usually closed questions – those with one correct answer - and the implied required register for meaning-making was written scientific English or a written symbolic register (see Figure 5.3 below). These kinds of activities dominated the textbook. In an analysis of the 13 activities in the chapter dealing with this topic in the textbook, all contained constrained seatwork activities which matched my definition above. Only three contained at least one activity which was more open-ended and constituted my category of guided meaning-making.

Constrained classwork: the textbook

Ms B drew all her seatwork activities from the textbook and it was the dominant LTSM in the class lessons. However, in an interview with me, Ms B expressed a dim view of the textbook: 'I don't really like it' and 'it's too simplified' (Teacher Interview 1). She expressed feeling compelled by higher authorities to use the textbook: 'that is what we have to use' (Teacher Interview 1). One of the senior teachers in the Science department confirmed that the learners' textbook is supplied by WCED and not chosen by the school. This teacher also told me that she encourages teachers to use a variety of textbooks for their own reference, but that teachers have to apply to the Principal for funding for these books (Fieldnotes, 310516). The learners used only the textbook, one worksheet and two tests as written resources during the class lessons on the topic.

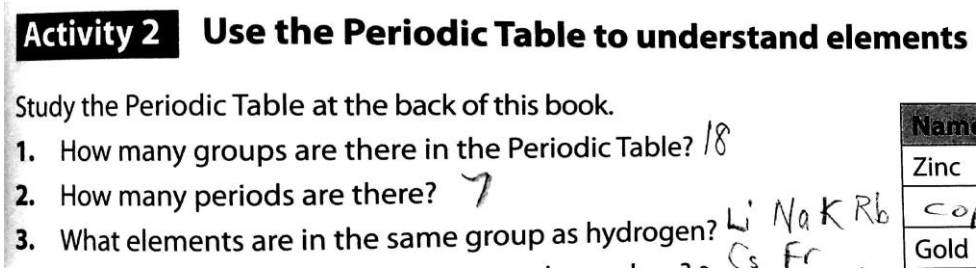
Ms B's criticism of the textbook was expressed in more detail during the first interview as follows:

Extract 5.7: Teacher interview 1. The textbook.

Ms B: it is so: simplified
and then it skips
um sections of the work that
uh
for example they can't understand
um reactions without understanding bonding and whatever (Robyn: right)
but the textbook does that
and CAPS does that

This comment was borne out by the content of the textbook. 'Bonding' is only referred to in the textbook topic as 'joining', such as in the statement: 'Compounds are made of elements that are joined together'(Bester et al., 2013, p. 79). The colloquial phrase 'joined together' is used instead of the scientific term 'bonded', therefore this important part of the conceptual framework of the topic remains in the everyday register and is not given the further scientific meaning that 'bonding' implies. The importance of bonding as a foundational concept in understanding chemical reactions was confirmed by a professor of Chemistry at the University of Cape Town (Prof. David Gammon, personal communication, 5 May 2016) who was surprised not to see the concept covered in the textbook.

Figure 5.3 consists of two photographs: the first is of the first three questions in Activity 2 from my copy of the textbook (Bester et al, p.77); the second is of a learner's exercise book with her written answers to these questions.



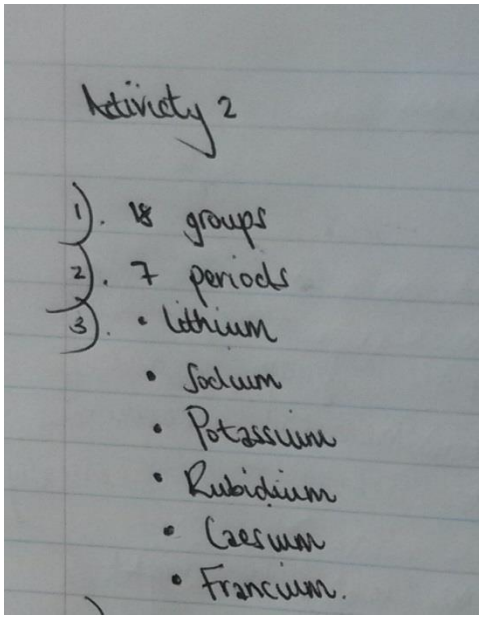


Figure 5.3: C1. Textbook activity and Nomsa's answers

As Figure 5.3 demonstrates, constrained seatwork activities produce a narrow set of responses, either a single word or only one correct answer. This narrow set of responses is easy to assess and correct, but does not reveal much about the learners' thinking process as they use the Periodic Table as a reference and decode it to answer the questions. Some of this 'hidden thinking' is, however, available in the spoken and bodily discourse of the learners as they discuss their answers while working with seatmates. This discourse was allowed but not encouraged by the teacher. On occasion, concomitant with this speech was spontaneous and exploratory writing in the form of notes and doodles aiding meaning-making towards the final answer. This spontaneous speech, action and writing is discussed in Chapter 7 when data

is presented in which the teacher circulates in the classroom and talks with learners about their answers and when learners discuss their answers with each other. Scholars have pointed out (eg. Brodie, 2010) that an opportunity for teachers to understand learners' thinking in response to constrained seatwork questions is also available during the 'go over' activity when learners offer incorrect answers. This is because at this point, the teacher or a learner has to give an account for the answer being incorrect which unearths the meaning-making behind the answer.

In the study group, constrained seatwork was less dominant and consisted of a weekly revision test of the 20 first elements in the Periodic Table and two written answers to textbook questions.

Testing

Test writing was unique in the discourse of both learning settings in that it is the only activity type where learners have no interaction with anyone else. Tests were undertaken in both class and study group settings, although in class the stakes were far higher: the class test was the only form of formal assessment in the topic. As Table 5.2 demonstrates, the test results of the learners were generally poor with the average being just above 50%.

Table 5.2: The test results of Grade 9B learners

Learner		**Mark /30**
Lindelwa		20
Lubabalo		14
Fezeka		14
Khethiwe		24
Nondozolole		22
Luthando		14
Babalwa		21
Asanda		18
Mandla		14
Palesa		12
Nandipha		18
Onke		17
Malusi		18
Zimkhitha		16
Dumisani		5

Sabelo		18
Zandile		16
Phumeza		18
Zodwa		14
Learner		**Mark/30**
Onele		18
Yonela		18
Veliswa		20
Thandile		16
Nobuhle		10
Vuyokazi		18
Nomsa		16
Mbulelo		13
Nomakhwezi		11
Thembeka		18

Mxolisi		19
Siphosethu		14
Lelethu		12
Mthobeli		17
Unathi		22
Songezwa		5
Average		**15.8 (53%)**

In this section, I focus on the discourse of the test and compare it with the discourse in the topic as studied in class lessons and study group meetings. While completing a test, learners interact solely with the text of the test. Discourse for testing is arguably the most constrained kind of meaning-making which occurs in a learning environment. Written presentational discourse adhering to a narrow definition of academic English for Science is demanded of learners in both receptive and productive forms of meaning-making (ie. reading and writing) when answering test questions. Other modes, such as the drawing of diagrams, are occasionally included in Science tests but when written language is required to be read or written it must conform to the register of reported science – one of many registers in which science gets done (Yager, 2004). Unless teachers write a memorandum for a test or create their own worksheet, they may never themselves have to produce the written scientific register that is required by learners in a testing situation (Shohamy, 2004). The question which the analysis below seeks to answer is: Did the observed meaning trajectory traced by learners extend from the classroom and study group registers into the written scientific register of the test?

Tracing the meaning trajectory of the learners through one semantic relation

The discussion below is based on a microethnographic analysis of one semantic relation, or meaning relationship, in the topic as it was realised through discourse and ultimately assessed in the end-of-topic test. The chosen semantic relation, which is depicted in Figure 5.1, can be rendered, following Lemke (1990, p.12) as follows:

ELECTRON → (arranged in) ELECTRON SHELLS

I trace this relation through the discourse of the class lessons, study groups and textbook to understand in what forms learners had encountered it prior to being tested on it, as well as considering how the meaning did or did not evolve on this trajectory. Beyond the scope of the analysis here, is how the trajectory stretches in space beyond school into meaning-making practices outside of school, as well as in time beyond the first study group and lesson on the topic.

The thematic-conceptual unit (Lemke, 1990) 'electron' is related to another unit 'electron shells' through the semantic relation of location 'arranged in'. The meaning that needs to be constructed through the discourse can be expressed as follows: 'electrons forming the atoms of different elements can be found in organised units called electron shells in ways which are similar and different to the electrons of other elements'. This semantic relation is an important one for learners to master as is shown by both its ubiquity in the classroom discourse and also its weighting in the test: eight out of 30 marks were directly related to this semantic relation. The test question pertaining to this semantic relation was posed as follows:

Extract 5.8: Question 2.1.3 of the end-of-topic test

Question 2

Helium is an unreactive gas used to fill up balloons and power air ships.

2.1.3 Neon is also an unreactive gas. How is the arrangement of electrons in Neon:

(a) similar to the arrangement in Helium? and (1)

(b) different from the arrangement in Helium? (1)

This question is a 'thematic nexus' (Lemke, 1990, p.101): 'a point in the dialogue where several thematic relations are all interconnected' (ibid.). In this nexus, at least three semantic relations from Figure 5.1 are interconnected:

ELECTRON → (arranged in) ELECTRON SHELLS

ELECTRON SHELLS	→ (part of)	BOHR DIAGRAM
BOHR DIAGRAM	→ (represents)	ELEMENT

Lemke (1990) suggests that a thematic nexus is difficult to interpret because the whole pattern is required to make sense of it. This whole pattern takes time to unpick; and it is a tricky knot to unpick linguistically due to the inclusion of a nominalisation – 'arrangement' - which is a typical grammatical convention of scientific English. This way of packaging a semantic relation is notoriously problematic for learners (Halliday & Martin, 1993) because the process of electrons being arranged is hidden within a noun phrase; and the action - and therefore connection to the concrete world - is lost. The prior knowledge of a concrete process required to unpack the nominalisation within this question in order to make deep conceptual meaning can be rendered as follows:

> Electrons are arranged in electron shells. The electrons of different elements are arranged in different ways in their electron shells. Neon and Helium are examples of elements which have electrons arranged similarly but also differently.

This knowledge in turn relies on other semantic relations such as the relation between 'electron' and 'proton' and 'neutron' and 'nucleus' or between 'elements' and 'compounds' and 'atoms' etc. (see Figure 5.1 above). It also relies on the learner's receptive meaning-making in understanding the word 'arrangement' in this context. Given this explanation of the high learning demand of this semantic relation, I turn now to an analysis of how learners' knowledge has been shaped through the class and study group discourse preparing them to be able to cope with the demands of this question.

The particular semantic relation under discussion appeared several times in the classroom discourse. Five examples appear below with the expression of the semantic relation underlined:

Extract 5.9: C1. Electron arrangement in oral discourse

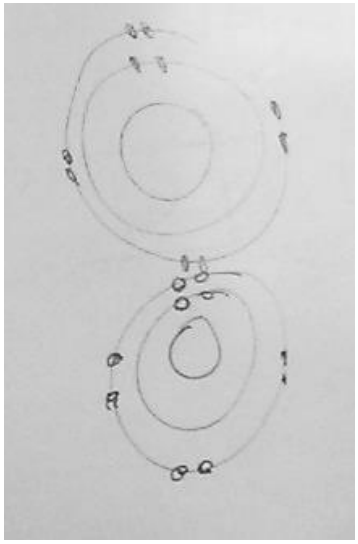
> Ms B: how many electrons go in the first shell

Ls: Two

Extract 5.10: C2. Electron arrangement in oral discourse

Ms B: you have electrons you don't just put everything in one shell but they are arranged in different shells

Extract 5.11: C10. Electron arrangement in Bohr diagram made by Ms B on the board



Extract 5.12. C10. Electron arrangement in oral discourse

Actor/Action	**Speech**	**Gloss**
Khethiwe, during class IRE discussion. (makes circling gesture with arm outstretched towards diagram on the board)	la one electron, 'pha kwa-atom…'pha kwi-copper kufuneka ibeyi1, ibe yi-oxygen neh? Ugcwalise 'pha, igcwala	that one electron, there in the atom… there in copper, must be one, it becomes oxygen, right? You fill it up there, it gets filled up.

Extract 5.13. C7. Electron arrangement in oral discourse

Turn	**Actor/Action**	**Speech**
1	T: Writes on the board	Twelve. Ok and then now the arrangement of electrons for sodium how many do I have on the first shell?
2	Ls:	Two.

3	T: Writes on the board	Two. Second shell?
4	Ls:	Eight.

There is great variety in the expression of the semantic relation in the data. However, the expression through nominalisation (ie. 'arrangement of electrons') was scarce. A search I conducted for the term 'arrangement' in the transcripts of all class lessons and study groups leading up to the test as well as textbook discourse turned up four instances in the spoken discourse of the class lessons (C1, C1, C4, C7) and one in the text of the textbook. The term was not used in the study group discourse. Of the five uses of the term, three referred to electron arrangement (C1, C4, C7), while the other two (C1 and p5, textbook) referred to element arrangement in the Periodic Table. While the use of 'arrangement' in another context may assist learners by repeating the pattern of nominalisation of this lexical item, there is no guarantee that its meaning will be carried over, especially when it is used so infrequently and without any metadiscourse (Gibbons, 2006; Lemke, 1990) about the term which would help learners to recognise it as a nominalisation and in so doing unpack its meaning.

The textbook used the term 'arrangement' in a heading close to the beginning of the textbook chapter dealing with chemical reactions: 'Arrangement of elements in the Periodic Table' (Bester et al., 2013, p.77). While this dense scientific language is given high status by virtue of its inclusion in a heading, no scaffolding of this term is given to learners in the form of metadiscourse. Indeed all the learner activities in the textbook make use of a register much more aligned with everyday social interaction, with no use of nominalisation, such as 'What elements are in the same group as hydrogen?' (Bester et al., 2013, p.77). This is much more accessible to learners than, for example, 'Explain the grouping of hydrogen with Lithium in the Periodic Table', which includes a nominalisation and a complex languaging task 'explain'. The register of the textbook matches Ms B's description of it being 'so: simplified' (Extract 5.7). However, as scholars have attested to in other Science classrooms (Lin, 2016), there is a mismatch between the register used in the textbook activities and the test questions. Added to this, it is likely that for most learners, the only independent reading of the content of the topic is during their seatwork when they complete the activities. Hence, they are not

encouraged to make meaning from written texts which include nominalisations such as those which appeared on the test. This analysis shows that prior to the test the learners had no practice in productive use of the scientific thematic unit 'arrangement of electrons' and scant receptive meaning-making practice. This use of nominalisation in the test would have been unfamiliar to the learners, doubly so given that these isiXhosa home language speakers would not likely have been used to the word used in everyday English either. They had to make the leap from fragments of the teacher's discourse in which the term 'arranged' was used to the highly complex productive meaning-making which was required to get a mark for the test question. In almost all cases, the leap was not made successfully. Eight out of nine learners' whose test scripts I collected received no marks for the test question under discussion. In contrast, a study on bilingual Science learners in the US has shown how teaching metalanguage from SFL, including the concept of nominalisations, can improve learners' ability to construct and deconstruct scientific texts (Gebhard, Chen & Britton, 2014).

I now move to an analysis of how the learners tackled the selected question in their test answers. I collected copies of nine learners' test scripts plus my own. In the absence of a marking memorandum, I will move straight into four examples (including my own) of answers given to question 2.1.3 (a) reproduced again below. Two were awarded 1 mark out of 1 and the other two were awarded no marks. Marks awarded are indicated in brackets after the learner answers.

2.1.3 Neon is also an unreactive gas. How is the arrangement of electrons in Neon:
(a) similar to the arrangement in Helium? (1)

Robyn: Neon, like Helium, has a complete outer electron shell. It has 8 electrons in its second shell. (1)

Lindelwa: Neon has the outer shell full. It cannot gain nor lose. So it is unreactive. They both can't react. (1)

Nomsa: They are both noble gases and stable. They have to rings on the outer shell. (0)

Palesa: It is similar because they both unreactive because they are in a same group and are noble gases cannot loose or gain electrons. (0)

All four of these texts reproduce accurate semantic relations within the topic as a whole. They also accurately comprehend the meaning of 'similar' in that they use the lexical units 'like' and 'both' which are semantically equivalent to 'similar'. However, only my own and Lindelwa's texts reference the semantic relation 'electrons (arranged in) electron shells', through the inclusion of the words 'outer shell'. Lindelwa's connection to electrons is implied and not explicitly stated like mine, but she nevertheless is awarded full marks, indicating that the semantic priority of the teacher is to the relation between terms and not the terms themselves, except when the terms are incorrect as in Nomsa's case. Nomsa reproduces the term 'outer shell' and the relation 'arranged in' ('have to rings'), but incorrectly uses 'rings' instead of 'electrons' as one of her semantic terms. Significant to this discussion is that all ten learners whose scripts I collected were able to draw the Bohr diagram for an atom of Helium and thereby scoring 4/4 for a previous question. This shows that we were able to reproduce the semantic relation in question through a diagram indicating our facility with the semantic relation in a graphical mode. The challenge for most learners came in expressing the meaning of the semantic relation in the written scientific English register.

Forming part of the teaching and learning of this semantic relation is the classroom discourse during the 'go over' (Lemke, 1990) activity which occurred in the lesson following the writing of the test. The teacher had marked the tests and was leading the IRE 'go over', or review of the test questions, while the learners were expected to participate orally and write down their corrections. Below I present the discourse during the review of Question 2.1.3 (a).

Extract 5.14: C10. Test review

Turn	Actor/Action	Speech	Gloss
1	Ms B: reading from the test addressing a learner	Ok so the next one <FAST> Neon is also a nonreactive gas </FAST> how is the arrangement of electrons in Neon similar to the arrangement in Helium Lelethu What did you say	
2	Lelethu:	(indistinct)	

3	Ms B: Holds right hand up with fingers in a 'C' shape Turns to board to indicate diagram Gaze to Lelethu for 3 seconds	It says <SLOW> how is the arrangement Not they are in the same group or they're both noble gases </SLOW> But how is the electron arrangement similar to that of Helium?	
4	Ms B: Gaze to Mbulelo Mbulelo turns head to face Ms B quickly	Mbulelo	
5	Mbu:	Yes, Miss	
6	Ms B:	What did you say	
7	Mbu: looks at test paper Hand to mouth Gaze to Ms B	Yho Hayi Irongo Miss.	Hey No It's wrong Miss
8	Ms B:	Tell us we'll decide.	
9	Mbu: left hand covers mouth Gaze to test paper Gaze to Ms B and shakes head	Ndithe misi	I said miss
10	Ms B: right hand covers mouth Gaze around room Gaze to Mthobeli	Mthobeli	
11	Thandile: whispering	(*indistinct*)	
12	Ms B:	Ok people who wants to answer	
13	Khethiwe: Raises her hand		
14	Ms B: gaze briefly to Khethiwe Khethiwe lowers hand	Um what is similar between the arrangement of electrons and helium and in Neon Did you draw the diagram for N^{eon}	
15	Ls:	//Yes// //No//	
16	Ms B: Erasing boardwork	You're saying no	

	Drawing on board	but then how are you going to know if you didn't How many protons and neutrons	
17	Yonela:	Ten.	
18	Ms B: Gaze to Yonela	T^{en} what	
19	Yonela:	Ten protons.	
20	Ms B:	Ten protons and neutrons So twenty	
21	Ls:	(indistinct)	
22	Ms B: Draws the diagram on the board Thandile shows Mbulelo something in his exercise book Ms B faces class	So how are they similar Yes	
23	Asanda:	Um they both have the maximum number	
24	Thandile:	In the outer shell	
25	Ms B:	Of what	
26	Asanda:	Outer number	
27	Thandile:	Of electrons	
28	Ms B:	Of electrons Yes <FAST> so they're similar because both of them have a maximum number of electrons on the outer shell</FAST>	

The teacher works hard here to draw out the correct answer through IRE discourse. She indicates in Turn 3 that the word 'arrangement' is important. She then draws out parts of the answer (ie. particular thematic units) from different learners, for example 'in the outer shell' (Turn 24) and ends by modelling a correct answer in the required scientific register. But as in the classroom discourse prior to the test, the learners haven't been given an opportunity to practise producing this register, and the full semantic relation, themselves. The teacher produces the correct answer in accelerated speech and moves quickly on to the next

question, so while she has asked them to do corrections, she doesn't leave time for inscribing or copying a correct answer. In this way the learning of a good expression of the semantic relation between electron and electron shells has been limited.

The last piece of data to be presented in relation to the testing of this particular semantic relation is taken from the second teacher interview during which Ms B and I looked at this question together and I asked her why she thought the learners had performed poorly on it.

Extract 5.15: Teacher Interview 2. Writing for Science

Turn and speaker	**Speech**
1 Ms B	I don't think the problem is was with understanding content but it's reading the question and maybe reading it again to understand what like what is needed (Robyn: m-hm) uh because when we were doing this in class were you there when we did the answers
2 Robyn	Going through the test Yes I was I was
3 Ms B	Yes ja they didn't have much of a problem with it like the answers were coming from them you understand so when they are now in a group they understand oh you want arrangement or this is what arrangement is
45 seconds pass in conversation about reading the question	
4 Robyn	do you think it's also challenging to put ideas into writing in the test or in any situation
5 Ms B	but we don't usually have like I would imagine that that would be a problem if they have to answer long questions or if they have to write an essay or whatever then it becomes a problem like their writing becomes really important here in grade 9 I don't believe we have long questions where it's usually um key ideas

	like here key ideas you need to mention that the one has 10 electrons another one has eight electrons there's not too much is it cre[ative writing] there's not too much ja that is involved here I think so no I wouldn't say the writing is a problem

In the interview, the teacher pinpoints the trouble the learners are having with Question 2.1.3 – 'reading the question' (Turn 1). She makes the point that in class they seemed to understand about the arrangement of electrons but not in the test. However, what is missing is a linkage of why they didn't understand the question on the test with the nature of the classroom discourse, more specifically an exposure to the mechanisms of the scientific register in English.

Ms B does not make the link between the difficulty of reading the scientific register with the difficulty of writing the scientific register when she says 'there's not too much…creative writing' (Turn 5) in Grade 9 Natural Science, attributing difficulty to length of written response and not to something inherent in the scientific register. She defers to my knowledge of different kinds of writing by querying her term 'creative writing' through rising intonation, perhaps acknowledging that this is the domain of language teachers not Science teachers. This was expressed by the teacher in her first interview. She separated language work, such as writing, from the content of her subject, as discussed in Chapter 4. This is not surprising given the curriculum in Ms B's undergraduate Science and postgraduate Science education studies which do not expose students to the language load inherent in all content subjects. Indeed, as was described in Chapter 1, the curriculum documents for Natural Science separate writing skills from the content of Science rather than seeing these as interdependent.

The register used to present this test question (as well as others) has become so accepted as the only register of a test that it seems like a truism to point it out. However, I will briefly probe the implications for learners' responses on the test inherent in the exclusive use of this register. As we have seen from the examples of the semantic relation in use in the classroom discourse, the teacher and learners use a register to express it which is much more aligned with their social identities: oral forms of a meshed scientific and social register including

gesture. The test offers and requires a narrow register which precludes the engagement of the learners' social identities. Gee (2004) argues that the move from lifeworld social languages to academic social languages represents an identity loss for children and this is why they sometimes resist the new social language or register. Lemke points out that learners will speak a 'hybrid' register before they learn to speak 'pure science' (1990, p.173). He positions this process, or trajectory, as natural. However, the fact that learners are on a journey which involves identity shifts is not taken into account when educators and examiners set tests. Learners are merely expected to 'leave part of themselves at the testing room door'. The journey towards becoming a participant in the social activities of Science requires the development of new academic identities which are productively integrated at times with the existing social identities of these teens (Ballenger, 2010).

The test provided an example of how learners' knowledge, even if conceptually accurate, does not count in assessment if it is not presented in the way the test demands (Shohamy, 2004). For all Science learners, but in particular emergent bilinguals, the condensed nature of written science discourse with its particular linguistic requirements such as nominalisations is challenging. The challenge increases if this language has not been modelled sufficiently for them.

The expressions of the semantic relation 'electrons (arranged in) electron shells' trace an idiosyncratic trajectory through the discourse of the classroom and the study group meetings. The following registers were represented: gesture, registers of English, registers of isiXhosa and diagrams. The discourse of the test required the reception and then production of written scientific English only. This constitutes a mismatch between what the learners were offered (and what they took up spontaneously) and what they were required to do in high stakes summative assessment. It also reveals the real preoccupation in constrained meaning-making with learners' narrowly-defined presentational discourse at the expense of their exploratory discourses; discourses which are inherently meshed and mostly foil attempts to categorise utterances as constituting one or other bounded register.

Extending the potential trajectory through translation

The different expressions of the semantic relation of electrons to electron shells in the classroom discourse spanned registers and modes. However, there are other registers and modes of expression which were absent from the discourse, but nonetheless intelligible to the learners. I was particularly interested in these expressions which relied on isiXhosa features as these were the hidden resources of the learners. During the time that I was working with Babalwa on translations of my transcripts, I asked her to translate the class test into isiXhosa and in the process found the following. She translated:

> 'How is the arrangement of electrons in Neon'
>
> as
>
> 'Zibekwe njani ii-elektroni kwi-Neon'. (how are the electrons placed in Neon)

By translating 'arrangement' as 'zibekwe njani' (or 'how are they placed') the essential meaning is retained, but the nominalisation is lost. 'Arrangement' is a noun, but 'zibekwe' is a verb. Thus, the grammatical feature of nominalisation is absent from the isiXhosa version. While the test translation was not used in my fieldwork, it served as a finding that while translations may be able to aid understanding, they may not necessarily model the features of presentational registers such as nominalisations. Potential alternatives to 'zibekwe njani' which include a nominalisation are:

> 'amalungiselelo' (arrangement – Nabe et al., 1976)
>
> 'ukubekwa' (placement – Gononda, 2013)
>
> 'i-arrangement' (arrangement –formulated with a language and literacy colleague, 11 September, 2017)

By working with these multiple versions, the uses and benefits of each becomes apparent. Xhosalisations (Paxton & Tyam, 2010) such as 'i-arrangement' might be seen as sloppy language use by purists, but this term retains the nominalisation in a way which the isiXhosa

phrase 'zibekwe njani' does not. 'Zibekwe njani' offers an everyday register expression of the semantic relation which is helpful in unpacking the nominalisation. Pointing out these different affordances to learners and exposing them to these versions – in other words the use of metadiscourse - enables the flexible expression of scientific meanings and language awareness (Lemke, 1990). Given the increased interest in creating glossaries for African language students in content subjects such as Science[38] attention should be given by translators to the grammatical features of registers such as those used in Natural Science in order to provide access to Science meaning in a powerful register.

Conclusion

In this chapter I have:

- sketched the scope of the topic called 'Chemical Reactions' in Grade 9 Natural Science;
- analysed the data to describe the category of *constrained meaning-making* in oral-dominated and writing-dominated learning activities;
- introduced the concept of *meaning trajectories* which were traced through the interactional data and learner texts for one semantic relation.

I have defined constrained meaning-making as constrained in terms of register, discourse structure and topic. In the constrained meaning-making reported in this chapter learners needed to conform to a version of science language which was narrowly defined. The use of isiXhosa language resources or action modes was not encouraged and at times even discouraged (as reported in Chapter 4 when learners censured each other with the call to 'speak English!'). In terms of discourse structure, turn-taking in the oral discourse in the whole-class setting was circumscribed and shorter learner texts predominated with only one 'voice' or 'view' being heard (Mortimer & Scott, 2003, p.33). There were few opportunities for learners to practise the discourse required by assessments and/or the scientific community. The topics studied were constrained by the demands of the curriculum and assessment requirements and, in this regard, they followed the teacher's interests.

[38] For an example see Open Educational Resource Term Bank online: http://oertb.tlterm.com

The kinds of Science meaning that the learners made under constrained meaning-making conditions varied. Some (such as Khethiwe) were able to successfully reproduce the constrained patterns which were required by IRE discourse or written activities such as testing. Others remained silent in the plenary. Still others made contributions which were incorrect when judged against the canon of school Science (such as Mthobeli) but were not assisted to move from this incorrect meaning to the correct one. Many were limited in their meaning-making in alignment with the school Science canon as evidenced by the test results. Where meaning aligned with the canon, learners could be said to have acquired (Gee, 2004) the discourse of school Science, but its appropriation (Bakhtin, 1981) was not able to be tested from the constrained meaning-making data available in this chapter as 'fixed words' predominated over 'flexible wordings' (Lemke, 1990, p.91). Due to the dominance of the voice of the teacher or curriculum in constrained meaning-making, the quality of the teacher's thematic development strategies (Lemke, 1990) was important. Good use of thematic development strategies provided a model for the acquisition of the scientific register, but did not necessarily enable the kind of appropriation of which Bakhtin writes (1981). In the constrained meaning-making reported in this chapter there is no evidence of learners who 'populate (the scientific discourse) with (their) own intention(s), adapting it to (their) own semantic and expressive intention' (ibid. p.293). Learners' lifeworld knowledge did not feature and there was little evidence of their social identities (Ballenger, 2010) being expressed in the data.

Constrained meaning-making was the dominant type in the class lessons which was reinforced through the single form of assessment being the summative test. The study of one semantic relation and its trajectory over the topic of study revealed that there was a lack of continuity between the meanings made by Ms B and her learners in classroom talk and action, and the meanings made in reading and writing the scientific register in the test. For the semantic relation selected, learners mostly failed to provide the canonical meanings in the 'flexible wordings' (Lemke, 1990, p.91) required by the test. A key element of the difficulty of the expression of this semantic relation in a written scientific register was the nominalisation: 'arrangement'. The difficulty was compounded by a lack of metalanguage used in either the class lessons or study group unpacking the meaning of the word. I provided versions of this

term in isiXhosa to demonstrate how these could be used to aid understanding of the nominalisation.

In the following chapter I will introduce and describe the second type of meaning-making: guided meaning-making.

Guided meaning-making

> *Learning, we suggest, needs to be seen as a dynamic process of transformative sign-making which actively involves both teacher and students.*
>
> - Kress et al., 2003, p. 13

Introduction

This chapter describes the practices in the classroom and the study group which I have termed *guided meaning-making*. I will show how guided meaning-making is contained in activities set up by the teacher or facilitator, but in which learners are encouraged to find their own path to meaning and express this meaning flexibly (Lemke, 1990), using their own words, drawings and actions. Some instruction is given by the teacher, or facilitator, which produces the meaning-making I report on here. Below I describe activities in which learners:

- draw diagrams and expound upon them in familiar isiXhosa
- engage with the teacher about their own learning in the topic
- complete a translation exercise between a number of registers in which scientific definitions are expressed
- design questions about the topic as a whole which then are sent to outside experts to answer and define their own investigation task.

These activities took place mostly in the study group where the constraints of timetable, curriculum coverage and assessment were not present.

Where the guided meaning-making is bilingual, this is the most transgressive kind of languaging in a post-colonial, Anglonormative (McKinney, 2017) context in which bilingual or CLIL (content and language integrated learning) programs are not in place. Indeed, the translation exercise I guided learners through in the study group – an example of official translanguaging (García & Li Wei, 2014, p.91) in which bilingual activities are designed by the teacher - directly flouted the language policy of the school which states that only English is the LoLT.

My analysis of the extracts presented below will show how the discourse structure in the plenary activities[39] which contain guided meaning-making differs from that in constrained meaning-making. Here learners were given much longer turns and responses were expected to be much more diverse than in constrained meaning-making. Questions were more open and learner interest was generally higher than in constrained meaning-making. The purpose of these activities was often the *process* of 'working on understanding' (Barnes, 1992) and not the *product*, in whichever mode. Barnes' description of 'exploratory talk', below, explains how this work takes place. According to Barnes, exploratory talk is:

> often hesitant and incomplete; it enables the speaker to try out ideas, to hear how they sound, to see what others make of them, to arrange information and ideas into different patterns. (1992, p.126)

The act of arranging 'information and ideas into different patterns' resonates strongly with Lemke's notion of 'flexible wordings' (Lemke, 1990, p.91) which he sees as so important to mastering the thematic relations of a Science topic. As outlined in Chapter 2, I am extending Barnes' concept of exploratory talk to include meaning-making in all modes, not just the oral, resulting in 'exploratory meaning-making'. Hence the exploratory meaning-making reported on here includes written texts, diagrams, spoken texts and gestures.

Study group semiotic practices

Most of the data in this chapter is drawn from the study group and hence an introduction to the semiotic practices of this group follows. The study group was, to my knowledge, an unprecedented group in terms of language practices at Success High. However, existing as it did with permission from the Principal, in the school library, within school hours, it was shaped in many ways by the language environment of the school at large. But it was also shaped by my language repertoire and practices insofar as I operated free of the constraints of the curriculum and language policy that other teachers were under. The group was conceived of as an established translanguaging space (García & Li Wei, 2014) with official sanction given to designed translingual practices, while the classroom was an adaptive

[39] Activities in which the whole class is focused on one activity led by the teacher.

translanguaging space (ibid.) where participants, if they drew on their bilingual repertoires, engaged in 'smuggling in the vernacular' (Probyn, 2009, p.123).

Learners participating in the study group had been exposed to an English-only approach to writing in content subjects from Grade 4 and so when asked to use any language to write about Science topics, it was unsurprising that all learners chose English. Indeed, Thandile explained that he uses English when he is required to be 'confident, sure' of the facts (Extract 4.21), which is the preserve of presentational meaning-making in writing and so isiXhosa was alien in that context. The learners and I fell easily into IRE teacher-talk when there was a need for exposition, as reported in Chapter 5, although this was not a predominant activity. We focused our learning activities on the topic of the curriculum which we were also studying in class and so language practices from the class were transferred into the study group, with reference sometimes being made to the textbook or what the teacher had said in class. Additional sources of information were also introduced such as Youtube clips and a worksheet I created and library books on the topic (see the list in Chapter 5). Our goal which we discussed at the outset was to study the topic and prepare for the end-of-topic test. However, we also diverged from the topic when the learners' interests directed us. The focus on the learners' (I include myself here) interest also had an influence on the activity types (Lemke, 1990) of the study group. There was space and time for learners to ask authentic questions which led to a large amount of true dialogue – an activity with the same structure as a social conversation (Lemke, 1990, p.55) - between all the members of the study group.

I now move on to describe the first collection of guided meaning-making activities which centred on learners' Science interests or 'puzzlements' (Alvermann, 2004, p. 232).

Eliciting and encouraging learner 'puzzlements' in the plenary

Alvermann's term 'puzzlements' (2004) helps to frame the four examples in this category of guided meaning-making. Puzzlements occur when there is something uncomfortable and unsettled for the learners which forms the impetus for further inquiry. This is either a question arising from the learners' interest, or two or more proposed learner answers which are in conflict. The term puzzlements foregrounds the moment of irresolution which is common to all the examples.

Eliciting learner questions

The first example of eliciting and encouraging learner puzzlements involves myself as facilitator of the study group asking the learners to draw up their own questions about the topic. Yager (2004) places high value on an activity such as this in Science:

> Often, the best context for learning occurs when issues (questions, problems, or concerns) are used to define and exemplify science content. Whenever possible, these issues should arise from student experiences, concerns, or both. (2004, p. 102)

Yager's contentions above about the importance of learners' curiosity in the learning process resonate with my lived experience as a teacher. Scholars in the field of inquiry-based Science have written eloquently on this topic (cf. Montuori, 2008; Alvermann, 2004). Indeed, our South African CAPS curriculum often reiterates that it is intended to be 'learner-centred'. However, CAPS stipulates daily and weekly content to be covered in every subject (as outlined for this topic in Chapter 5) and so time for learners' questions to be given due attention is scant. Given the few constraints in our study group, I was able to design an activity based on learners' questions about chemical reactions. This activity spanned the length of the study group's existence with references to these questions in the final sessions. Below I describe the three phases of the activity which comprised much guided meaning-making.

I was fortunate to have started the study group meetings before the topic began in class and so could do some work with our prior knowledge. Determined as I was to make the study group a context for real learning, and free as I was from the constraints of the curriculum, I asked the learners to formulate their own questions related to the topic of Chemical Reactions in the first study group. These questions, including my own, were formulated during the first study group meeting. I then wrote these up on two large sheets of newsprint and displayed them against the library shelves at most study group meetings. I proposed the activity as follows:

Extract 6.1: SG1. Setting up the activity

> Robyn: Um but let's just do a quick activity, and that is write down three questions that you have about chemistry or chemical reactions. Anything. Try and write on

> something you've really been wanting to know. Or if you think about chemistry, what would you want to know. Even if it's what is the point of studying, how can this help me in my career. Even if it's something like that. Any three questions that you have about...about chemistry, chemical reactions.

By framing the questions as those 'you've really been wanting to know' I focused on eliciting the learners' interest. They took up the challenge and wrote down their questions. I did not specify which linguistic resources they should use, but they all unsurprisingly used only English resources given their schooling history explained above. After they had each selected one of their questions, I wrote what Chin (2001) termed their 'wonderment questions' (as cited in Alvermann, 2004) up onto newsprint. Chin described two kinds of student-generated questions in her study of eighth grade chemistry students: *wonderment questions*, which consist of higher level processing and *basic information questions*, consisting of factual or procedural level questions. She found that students did not generate wonderment questions on their own and:

> this suggested to her that leaving such questioning to chance was tantamount to letting students' puzzlements go undetected – in effect, stifling further inquiry. (Alvermann, 2004, p. 232)

Chin therefore makes a strong case for designing learning activities which require learners to ask wonderment questions.

Some questions were transcribed verbatim and others were changed slightly by members of the study group to aid coherence. As scribe, I tried to remain as true to the author's intentions as possible, without ironing out any conceptual inaccuracies I noticed as I imagined these would be good fodder for discussion later on. One example of the joint construction of a learner's question follows:

Extract 6.2: SG1. Joint construction of a wonderment questions

Turn	**Actor/Action**	**Speech**
1	Palesa: Looks up from page, shakes hand by twisting wrist	(Indistinct)When gas particles diffuse, are the particles completely disappearing or they just float til an en' where they (indistinct)

2	Robyn:	Ok. Say the first part again?
3	Palesa: Holds book with both hands and reads Lets book go, looks up at Robyn and others, smiles Describes circles with extended hand and moving fingers looks at neighbour who is smiling with raised eyebrows Robyn writes	When the gas particles diffuse are the particles disappear completely or they float around
4	Ls laugh	(indistinct)
5	Thandile: smiling	They don't float.
6	Robyn:	Ok. So what do we write down for the end? Do they disappear completely or just float? Or do you want me to write something else?
7	Robyn Writes: 'When the gas particles diffuse do they disappear completely or just invisible/float?'	
8	Khethiwe:	Or just like invisible.
9	Palesa:	E-e. (yes)
10	Robyn:	I'll put float and invisible. We're gonna have to we'll have to decide what to

Palesa and her peers engage in a variety of meaning-making practices during the presentation of her question for inscription. Instead of merely reading the question verbatim, Palesa prefers to elaborate and extend her meaning through the use of gesture and exploratory talk. The question is an intriguing one with many concepts or semantic relations caught up within it. There is so much to define before the question can be answered. When her written words begin to fail to capture her meaning, she looks up from the page and employs gesture to try to communicate her intentions better. This demonstrates her interest in being understood and in the question. She could have just followed my instruction to read her written question aloud, but she prefers to 'work on understanding' in a more public space before committing to it.

The full list of questions as they appeared on my newsprint after that first study group meeting are as follows:

Extract 6.3: SG1. Learners' elicited questions

1. Fezeka: When you have mixed atoms and they've made a chemical reaction, can you separate them?
2. Thandile: Is everything around me made of atoms?
3. Lindelwa: Why are electrons and protons always equal?
4. Siphosethu: Why do chemical reactions happen?
5. Khethiwe: Why does oxygen and hydrogen make a liquid (water) when both are gases?
6. Nandipha: Why is an element made out of atoms?
7. Phumeza: What effect do chemical reactions have on our lives?
8. Lelethu: What jobs are closely linked to Chemistry?
9. Palesa: When gas particles diffuse do they disappear completely or just become invisible?
10. Yonela: Are there any jobs in the field of chemical reactions?
11. Mthobeli: What are the things that you will see or notice if the reaction has taken place?

Apart from questions 7, 8 and 10, which relate the topic to the life worlds of the learners, all the questions can be classified as wonderment questions about Chemistry in that answering them requires higher level processing and a complex and lengthy answer. The aim of the question-writing exercise was not to create scientifically accurate questions, but rather to begin to explore ideas about the topic. The questions do contain inaccuracies. In Khethiwe's question, for example, she states that oxygen and hydrogen are both gases. This is not always the case, as both of these elements can change state and become liquid or solid at different temperatures. However, as stated above, this inaccuracy was left unrevealed until the fifth

study group when we reviewed the learners' questions to see whether they had gleaned any answers from their study of Chemical Reactions.

The second phase of the activity was to track the progress of the learners' thinking in relation to their question as the topic progressed. The following extract is of the discussion of Khethiwe's question in SG5:

Extract 6.4: SG5. Khethiwe's question

Turn	Actor/Action	Speech
1	Robyn Robyn looks from question on the newsprint to Khethiwe	and Khethiwe, how are you doing with your question
2	Khethiwe	m_m
3	Robyn	What would you what would your answer be to your question at the moment and let's see if it changes from now until the end of the term just read it out
4	Khethiwe, reading: Robyn's gaze is on Khethiwe Khethiwe looks at Robyn Khethiwe:	Why does oxygen and hydrogen make a liquid which is water when both are gases? Miss I have no idea (indistinct)
5	Robyn: Eyebrows raise and gaze moves to Anelisa	How much can how much can you answer like give something towards an answer cos it happens right . so
6	Khethiwe: Hand holding pen goes to mouth, Anelisa looks down at her pencil case Khethiwe:	mm … <FAST> I think because hydrogen has um metal properties </FAST>right
7	Robyn: Khethiwe: strokes paper with pen, Gaze to Robyn Robyn:	It's on the left hand side ja Ja With the metals ja

8	Khethiwe traces a circle with her pen on the paper while gaze is still to Robyn Gaze is to page Taps pen on paper and gaze to Robyn	And it reacts with uh oxygen I think um the oxygen you know kind o- loses that gas form I think they come to a compromise
9	R, smiling, spoken very quietly	They come to a compromise
10	Khethiwe Looks from her book to Robyn and back. Draws circles on her page	Metal liquid liquid's like in the like a semi-metal cos water is a semi-metal so those are metal here those are non-metal here and they come to a compromise to uh (indistinct) that's what I'm thinking

I will begin with an examination of the epistemological assertions about Science which are expressed in the guiding moves I make in Extract 6.4. First, I emphasise to the learners the *process* that is involved in conceptual development in Science. 'What would your answer be to your question at the moment' (T3) and 'give something towards an answer' (T5) leaves open the possibility that that answer may change and that an incomplete answer is also useful for learning. This also draws attention to the learners' thinking – or introduces metacognition which Khethiwe picks up in Turn 10: 'that's what I'm thinking'. Second, I draw attention to the empirical nature of Science, reminding the learners that this is not just a theory but that 'it happens [right]' (T5).

Khethiwe is on the receiving end of my probing as I withhold my own ideas and push her to express hers. Khethiwe expresses her thoughts on how liquid water is formed from two elements which are, in her current understanding, always gases. The concept around which Khethiwe's question pivots is that matter can be described in different ways: two of which are states and the metallic properties of elements. The pauses in her speech indicate her hesitance and discomfort with these ideas. She also hedges by using the phrase 'kind o' and 'you know' (Turn 8). She arranges information into different patterns in Turn 8. These features of her speech indicate that she is engaged in exploratory talk (Barnes, 1992). Mental effort is often also expressed physically and Khethiwe's effort is revealed through her actions: she

draws circles on the page; her gaze is on the page and not on her interlocutors. Then, she engages sophisticated concepts from her life world to provide an analogy using personification for what happens in a chemical reaction ('they come to a compromise'), thereby engaging in the thematic development strategy of rhetorical connection (Lemke, 1990). I am able to support her in this strategy by repeating what she says and smiling which allows her the space and confidence to talk further into the concept. Lastly, she reveals her conceptual error in conflating state of matter with the metallic properties of elements through her exploratory talk 'water is a semi-metal' which I pick up in the following few turns.

Differently to her peers when they engage in exploratory talk, Khethiwe uses English. As her main interlocutor, I am English-dominant and so she accommodates my language repertoire through this. But Khethiwe is also particularly proficient in English in comparison with her peers due to her bilingual home. Other learners might not be able to engage in such conceptual depth in English and would need interlocutors with a wider repertoire than I have to engage successfully in exploratory talk of this nature.

Part way through the study group series, I added another piece to this activity in an effort to make the questions part of scientific inquiry more broadly. I sent the eleven learner questions to three adults I knew who are, or have been, involved in scientific inquiry post-school. I was careful to select one black, one coloured and one white adult as I hoped they would act as diverse, positive role models for the learners. One is a professor of Biology at a university, one holds a doctorate in Microbiology and one is an Economist. I asked them to select a question that they would be interested in answering and record a video of themselves answering it. They were asked to address the learner whose question they were answering and to keep their response to 1-2 minutes. They were free to answer in any way they liked. I then asked them to send the video to me via Whatsapp so that I could show my learners. A transcript one of the videos is found in Addendum 7. The purpose of these videos was threefold:

- to expose the learners to another authority on the topic of chemical reactions and to demonstrate the relevance of the topic beyond the classroom walls
- to provide a development of the topic using Lemke's strategy of 'repetition with variation' (Lemke, 1990)

- to give the learners the message that an adult who is part of an aspirational world of work cares enough about them to take the time to make a video which might help them in their learning.

I showed the videos to the three learners whose questions the adults responded to towards the end of my fieldwork. Their body language expressed their interest in them (leaning towards the screen, sitting upright), but unfortunately, we did not have time to discuss the videos.

Asking open questions

Open questions– those which do not have a definitive answer and require an extended response text from a learner – are inherently guiding rather than constraining. At moments during the IRE discourse of 'go over' Ms B would withhold her evaluation move in order to allow the learners to decide which of two or more possible answers is correct. In the example in Extract 6.5 below, the textbook activity (Bester et al., 2013, p. 128) was to write down the compound formula for magnesium hydroxide.

Extract 6.5: C7. Two answers compared on the board

Actor/Action	**Speech**
Ms B: Turns to walk towards board Writes on board: MgOH $Mg(OH)_2$ Turns towards learners and opens arms with palms facing out	What is the difference. Uh. Ok. Some said MgOH and others… (Ls: H O) M G O H (Ls: H O) and others M G (Ls: H) O H 2. (LF: Miss) So those are the two answers we have [right]

Instead of evaluating the first two responses she received, Ms B followed up immediately with a question to the whole class, 'What is the difference?'. She then entextualised the oral responses of the two learners on the board and checked whether those were the only two answers learners had given in their seatwork. The contrast question at the beginning of her turn still stands and a response from the learners requires extended reasoning. Side-talk and

further questions to Ms B ensue. In Extract 6.5, by withholding her evaluation move and instead following up with an open question, the teacher begins to guide the learners in their own struggle to make meaning.

Asking authentic questions

The next kind of guided meaning-making activity is the initiation of true dialogue by the teacher or the facilitator through the asking of authentic questions. True dialogue, Lemke holds, is one of the rarest activity types in a classroom. This is when teachers ask authentic questions or questions 'to which they do not presume to already know the "correct answer"' (Lemke, 1990, p. 55). Lemke laments that true dialogue in Science classrooms is often limited to topics other than scientific ones, such as classroom business. Asking authentic questions constitutes what Mortimer and Scott (2003) would term a dialogic communicative approach and Lefstein and Snell term dialogic practice (Lefstein & Snell 2011, 2013). Furthermore, Ernst-Slavit and Pratt (2017) assert that, 'teacher questions can serve as models for the kinds of questions we want students to ask' (p.1). They introduce 'reflective questions' (p.4) as a category of teacher questions which are open and authentic and aimed at getting learners to engage with their own thinking. In the examples below, the teacher and facilitator did not already know the answer to the question asked of the learners.

Extract 6.6: SG4. Authentic question in study group

Turn	Actor/Action	Speech
1	Robyn	So we we starting with the re- the chemical reactions, how you finding all of that about naming compounds
2	Khanyiswa	Yoh
3	Robyn	And how do you find all of that
4	Khanyiswa	Sometimes you just forget like
5	Nomvuyo	Ja it's very hard like the
6	Robyn	The rules of how to make the di-s
7	Robyn	yes
8	Nomvuyo	The tetras
9	Robyn	Yes yes
10	Nomvuyo	//The pentas//
11	Khanyiswa	//The mono-// but the monos easier, i-mono, mono like
12	Robyn	It's monoxide when it's one

13	Khanyiswa	Yes
14	Nomvuyo	And then like the others you remember cos penta it's 5 and then the shape of the pentagon
15	Khanyiswa	Pentagon 5 sides

An advantage of a study group is the opportunity it provides for reflection on the learning that takes place in the class lessons. In this extract, I asked the learners to reflect on their own learning, which resulted in metadiscourse about the derivation of the name given to compounds (T12-T15). This resulted in the learners making connections with Mathematics and shapes and sharing this knowledge with each other.

The second example of an authentic question is drawn from the class lesson in which the test was written. Just before beginning a new topic, Ms B asked the class, 'So how was the test?' (C9). This utterance was fast-paced compared to her preceding speech indicating a break from the topic at hand and perhaps a positioning of the topic of learners' personal experience of the test as subordinate to the Science content. However, Ms B stood still after asking this question and watched the ripples of responses made in side-talk amongst the learners for 13 seconds, only interacting with them when Yonela engages her in a verbal answer. During these 13 seconds, almost all the learners talked and gesticulated at the same time. Interest in this authentic question was high as indicated by the volume and tenor of the talk and the variety and animation of the gestures. This served as a moment of catharsis after the tension of the test.

Incidental learning

Towards the end of our first study group meeting there was a liminal period – a period of no focused topic-specific activity (Lemke, 1990) - as participants began to pack away. During this period, Siphosethu picked up my box of coloured-pencils which we had been using and looked at it. Khethiwe, who was sitting opposite her, read the words 'Wood-free' which appeared on the back of the box and began asking what that meant. This provoked an exploration of the pencils and the meaning of the words, followed by the collaborative framing of an investigation question which is represented in the extract below. Prior to the extract, I had encouraged the learners to break a pencil in half to see what was inside and they had

suggested that it was made of plastic: 'Yiplastiki' ('it's plastic'). The learners were currently practising investigation tasks with Ms B in class – an activity which forms a significant part of the assessment in Natural Science. The episode represented in Extract 6.7 follows on from the breaking of the pencils.

Extract 6.7: SG1. Wood-free coloured pencils

Turn	Actor/Action	Speech	Gloss
1	Robyn: Standing still, returning the pencils to the box	I'll give you a prize if you give me a good answer.	
2	Nandipha	Eyoba?	About?
3	Khethiwe Raises eyebrows when looking at Siphosethu	What's the question? What's the aim //of the investigation?	
4	Robyn	//What is the question? What is the question?	
5	Khethiwe	What's the ai-m	
6	Nandipha	What is the question?	
7	Khethiwe	the ai-m	
8	Robyn Learners start to open books and prepare to write	We want to know what's what are these made of?	
9	Nandipha	Oh hayi ke. Balela mna. nqwaba.	Oh well then Let me write it down now
10	Robyn	I'll give you a prize.	
11	Phumeza	Zibhalile ngoku	Written them now
12	Thandile: Reaching out for the box which Robyn passes him	Can I see any of those crayons	
13	Nandipha, laughing with her neighbour	N'dzo qala ndibhale "what is the question?"	I'll start off by saying: "what is the question?"
14	Khethiwe	What are are are . ithi nanto . kuqala	What are are are . what are these . first
15	Nandipha, reaching out for the box, which Thandile doesn't relinquish	Can I? what?	
16	Thandile: reading from the box	//Wood-free not//	
17	Phumeza	//Khethiwe ziphelile ngoku//	Khethiwe they are gone now

18	Khethiwe: pages through her exercise book, shakes head, frowning, then wide eyes, gesturing with hands, raised eyebrows, Phumeza smiles broadly	Huh-uh ne investigation de ai-m we-investigation	No, you see investigation the aim of the investigation
19	L1	Kuthini le nto	What is this thing?
20	L2	Kwenziwa ntoni apha guys?	What is being done here guys?
21	Phumeza	Kubhalwa i-question.	A question is being written
22	Khethiwe (smiling)	Find the ai-m	
23	Phumeza: (looks at the box in Thandile's hand, then addresses Nandipha, then the whole group pointing at the coloured pencils)	I-investigation. Kwenziwa i-investigation to find out ukuba yenzwe ngantoni le nto. Yintoni igama lazo Igama lazo Yintoni igama yezi zinto.	An investigation. We're doing an investigation to find out what this is made of. What is the name of these The name of these What is the name of these things
24	Lelethu	Iyenziwe ngantoni.	What it's made of
25	Phumeza	Yintoni igama lazo?	What is the name of these?
26	Thandile: writing	What do wood-free coloured pencils made of	
27	L3	Wood ntoni?	Wood what?
28	Phumeza, while writing	Wood free.	

Shifting from a period of social conversation, the learners spontaneously frame their activity as the formulation of a Scientific investigation question – conforming to the conventions of this genre taught to them in Natural Science class: ie. the **aim** of the **investigation** should be clear and can be stated as a **question**. The words I have bolded in the previous sentence are used repeatedly by the learners in their discourse (see T3, T13, T18, T21) and signal a 'syndrome' of the language of Science as described by Halliday and Martin below:

> Any variety of a language, whether functional or dialectal, occupies an extended space, a region whose boundaries are fuzzy and within which there can be considerable internal variation. But it can be defined, and recognised, by certain syndromes, patterns of co-occurrence among features at one or another linguistic level...Such syndromes are what make it plausible to talk of 'the language of science'. (Halliday & Martin, 1993, p.4)

Khethiwe repeatedly utters the word '**aim**' a total of five times in the extract using the same intonation, beginning in T3 by using all three content words in her lexically dense utterance. Without being instructed to do this, the learners make the link between the instruction to 'find out…give me a good answer' (Turn 1) and the genre of investigations for Natural Science. This demonstrates their capacity to apply scientific conventions to everyday problems. In this way they enact a frame shift (Lefstein & Snell, 2011) and move from a conversation genre to a Science investigation genre.

The episode is remarkable for its collaborative nature which forms spontaneously. The learners pass the box of pencils around so that different learners can have a tactile experience of the box and read its printed words. The gaze of the learners marks a shift in the usual referencing of the teacher in learning situations as the authority. Here, these learners direct their gaze towards each other and the object of interest, the box. Through their activity and gaze they all demonstrate their investment in the task. I contribute to this shift towards a learner-directed activity. I set the activity in motion through the challenge offered in Turn 1 but then, after Turn 10, take up the role of bystander (Goffman, 1981) by keeping silent and focusing my gaze on the things I am packing away. Different participants contribute different utterances until finally a written expression of a question emerges. I begin by focusing the group's attention on the *aspect* of the pencils which is to be investigated: their *composition* (T8). Khethiwe then brings into play the *name* of the object of study (T14) which Phumeza refines (T25). Thandile supplies the name (T16) and then assembles the full expression of a question (T26) which the group, through the action of inscribing this into their notebooks, accepts. Throughout the extract other participants go about their meaning-making through multimodal practices sometimes by enlisting others (eg. through a direct question), sometimes privately (eg. by taking the box of pencils to read). This then is how the participants contributed to the content of the question. Their joint achievement of this investigation

question has enabled them to be in the best possible position to achieve 'a good answer' and therefore win the promised prize. They also each contribute different features of their semiotic repertoires to 'get the job done'.

In the spoken mode, the learners draw feely upon features of registers in 'English' and 'isiXhosa'. Phumeza's utterance: 'Kwenziwa i-investigation to find out ukuba yenzwe ngantoni le nto' ('We're doing an investigation to find out what this is made of') is particularly heteroglossic, meshing elements of 'English-isiXhosa' scientific discourse ('i-investigation') with 'everyday English' ('to find out') and 'everyday isiXhosa' ('yenzwe ngantoni le nto'/what this thing is made of). Hopefully this analysis in which I construct and name discrete registers ('everyday English', 'English-isiXhosa scientific discourse') reveals its own absurdity: the register Phumeza uses is so meshed that to tease out each contributing feature becomes like the futility of splitting hairs. From her point of view, she is naturally drawing on the features of her repertoire that are the best fit for getting the work of creating a question done efficiently and meaningfully – quintessential natural translanguaging (García & Li Wei, 2014). Significantly, when the learners arrive at the formal written mode at the end of their deliberations, they discipline themselves into a register approximating a monoglossic scientific English without being directed to do so. I argue on the basis of the data from the study groups when learners resisted writing about Science in isiXhosa that this is because writing about Science has only ever been done in English by these learners.

While the spoken mode is highly heteroglossic, the extract also comprises dense multimodality. In my use of multimodality here, I follow Kress et al. (2014) in indexing meaning-making which is not only reliant on the presence of the different modes, but reliant on the interaction between them. Kress et al. (2014) assert that 'meaning resides in the *combined effects* of the orchestration of the modes by the producer and by the reproducer, in the *interaction* between what is said, what is shown, the posture adopted, the movements made, and the position of the speaker and the audience relative to each other in the interaction' (p.18). This is well explicated in the case of Khethiwe's meaning-making in this episode. I will focus here on one of her utterances captured in the video still below:

Figure 6.1: SG1. Video still of 'de [ai-m] we-investigation' (Turn 18, Extract 6.7)

At least eight modes of Khethiwe's meaning-making are discernible in this moment, relying on the audio and video recordings and my memory of it: facial movement (eyebrows raised, eyes wide, smiling), gesture (fingers forming 'o'), body positioning (leaning forward), gaze (at friend who asked the question), meshed lexical mode[40] (Esengingqi[41], Science English), voice volume (increased), vowel length (extended), intonation (rising tone). These modes combine in a powerful meshed identity performance to realise a highly complex and nuanced meaning.

The modes Khethiwe employs to make meaning here assemble in such a way to create role distance (Goffman, 1975) between herself and a 'virtual self' (ibid. p.124) to which she does not want to appear attached. Her lexical mode includes features of scientific English drawn from her school Science curriculum: 'aim' and 'investigation'. While uttering these features, Khethiwe exaggerates the performance of an academic identity through:

- making conspicuous the gesture of fingers making a circle
- smiling with eyes widened and eyebrows raised
- a lengthened vowel
- rising tone
- forward body position
- and directing her gaze at her friend.

[40] 'Lexical mode' here is taken to be the meaning of the lexemes without references to the intonation, accent, volume etc. of the spoken utterance.
[41] Esengingqi is the term the learners used to describe the language they speak in the local area (SG8).

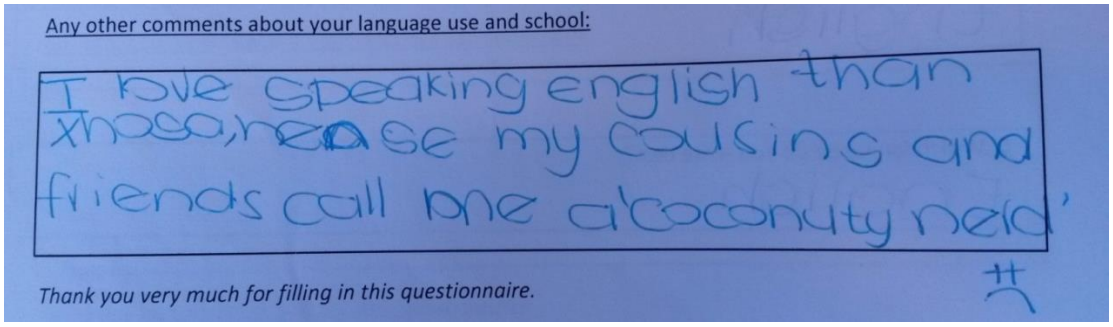
That this is meant to be read as a performance and not her 'true self' is underscored by the embedding of the scientific English terms in her familiar register. The use of local urban vernacular (or 'Esenginqi' to use the learners' term) and the action modes here realise her active manipulation of the situation in which she is a performer trying to maintain her poise, as argued by Goffman:

> The image of (the performer) that is generated for him by the routine entailed in his mere participation - his virtual self in the context - is an image from which he apparently withdraws by *actively* manipulating the situation. (Goffman, 1975, p.124).

Khethiwe's performance is supported by her peers, particularly Siphosethu and Phumeza, who respond through uninterrupted gaze directed at Khethiwe, smiling and positioning their bodies to face her.

That she utters the scientific English lexemes spontaneously in social conversation is highly risky for Khethiwe. She has previously been cast by her peers as a swot and a cultural sell-out. She expressed this in a voluntary comment at the end of her language questionnaire:

Extract 6.8: Khethiwe's language questionnaire



Transcription: I love speaking English than xhosa, hense my cousins and friends call me a 'coconuty nerd' ☹. [42]

[42] This response is itself heteroglossic. Even as Khethiwe bemoans her status as a too-studious ('nerd') black person affiliating with white culture ('coconut', derogatory) she reveals it to be true through her use of the stuffily academic term 'hense'.

It is the management of this identity risk with which Khethiwe is concerned as she affects a disdain for the role of English academic know-it-all through performing the dramatic orator. Goffman argues that:

> an individual may affect … a visible disdain for a role … in order to defend against the psychological dangers of his actual attachment to it. (Goffman, 1975, p.124)

Kapp (2004) found similar risk management in her study of English in a Khayelitsha high school in Cape Town where she concluded that 'to be seen to be investing in English… is to risk humiliation and derision' (2004, p.258). Even when the named language of the students and the Science discourse is the same, the appropriation of the register of Science can pose identity risks for students. Such was the finding of Brown (2006) in his study of black minority youth in Science classes in the US.

Another motivator of Khethiwe's utterance is her human interest in joy and humour, or what Huizinga (2014) describes as, 'the playful character of many social, cultural and political practices' (as cited in Blommaert, 2017, p.3). This motivator is in evidence in her catching her friend's eye and Siphosethu's laughter as she looks on. Another instance of the joy of play is evident in this episode in Nandipha's utterance, 'n'dzo qala ndibhale "what is the question?" '(I'll start off by writing: 'what is the question?') which accompanies laughter shared with her neighbour. Having not asked the participants about their laughter during this episode, I can only speculate that it is due to their delight in their own cunning at having linked a seemingly social activity of working towards a potential prize to an academic genre used in class lessons and the fun they are having in simultaneously playing and ridiculing 'the academic'.

Khethiwe performs multiple (or hybrid) identities in one moment captured in Figure 6.1. Canagarajah holds that constructing hybrid identities is integral to the language acquisition process (Canagarajah, 2004). Khethiwe is in the process of acquiring an academic register for Science and the hybrid identity she displays here will help her in this process. Ballenger (2010) also recognised that simultaneously performing social and academic identities was important for learning in Science amongst her bilingual primary school Science participants.

Official trans-semiotizing as seatwork

In Chapter 2, I argued for the use of the descriptor 'official trans-semiotizing' for those meaning-making activities which involve moving between, or translating between, two different registers or modes while drawing attention to them. In their taxonomy of possible translanguaging strategies, García and Li Wei (2014, p.120) include the following which I construe as 'official trans-semiotizing': translating, reading/comparing multilingual texts including visuals, multilingual writing, creating multilingual word walls. García and Li Wei's strategies involve the presence of more than one named language, whereas I conceive of trans-semiotizing as being possible between modes without alternating named languages. In the more constrained space of the classroom (described in Chapter 5), oral English registers of Chemistry and the written symbolic register of Chemistry were predominant, with diagrams being of secondary importance. The textbook offered one interesting official trans-semiotizing activity, but this was not undertaken by the learners. It involved making playdough models of molecules, hence transitioning from the written verbal or symbolic registers into 3D object creation (Bester et al., p.84). In the study group, the experimental nature of the space; the easing of the pressure of assessments; and its nature as an established translanguaging space, there was room for more official trans-semiotizing. In the analysis below, I will concentrate on two activities I designed which constituted official trans-semiotizing: the first involved moving from drawing and speaking to writing and the second moving from formal isiXhosa Science definition to English to what the learners called 'Esenginqi'. While I have just described these activities very bluntly in this summary, they both involved the recruitment of many modes and registers.

From drawing to writing in isiXhosa

As the study group sessions commenced before the start of the topic 'Chemical Reactions' in class, I began with a review of what the learners knew about the topic from previous study in Grade 8 or elsewhere. Due to my interest in drawing on different modes for exploratory discourse, I asked the learners to draw a diagram of a chemical reaction. I explained that it could be a general representation of a reaction, or could denote a specific reaction. Once the diagram was completed, I asked learners to explain what they had drawn in written isiXhosa. This requirement was met with shock and dismay. This was the first time these bilingual

learners had been asked to write anything at school, outside of the isiXhosa subject classroom, in their home language. The requirement directly flouted the school's language policy, although this was not a concern for the learners when faced with the huge task of a totally novel register as their only means of expressing themselves. All the learners who undertook this activity found it difficult. Below are some of their reflections after completing the activity:

Extract 6.9: SG8. Yonela's reflections

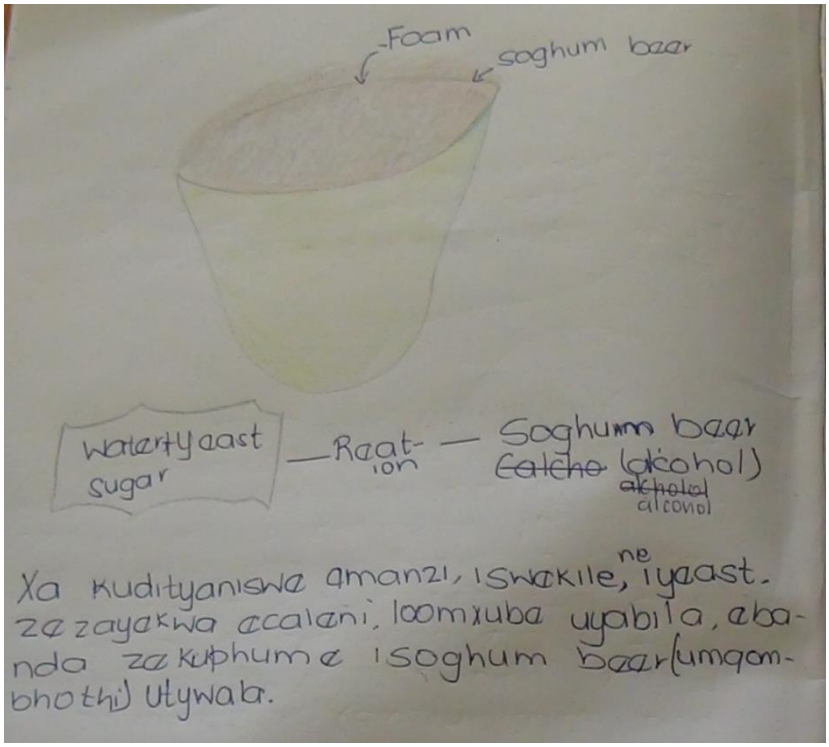
> 'Yoh, very hard…like there were other terms that you couldn't where you couldn't like explain in Xhosa like chemical reaction' (Yonela)

Extract 6.10: SG3. Khanyiswa's reflections

> 'it was quite difficult, it was like a new language' (Khanyiswa)

Terms that they had no problem incorporating into their spoken registers in the classroom such as 'i-reaction' suddenly posed a problem for them in writing. The standardising force of writing bore down heavily on them until they relaxed into flouting the written, standard isiXhosa that they are used to using in isiXhosa Home Language class. The accompanying talk with one another was crucial in achieving this.

Despite the difficulties the learners' faced, they all produced a paragraph of text in a short space of time. Below I have reproduced Khethiwe's complete text: image and followed by explanation.



Gloss of linguistic text:

If you mix water, sugar and yeast together, then put it aside, that mixture boils. When it has cooled it will become sorghum beer (umqombhothi) alcohol.

Figure 6.2: SG3. Khethiwe's prior knowledge text

The purpose of this activity was for learners to explore their prior knowledge of chemical reactions using an expanded repertoire (Lin, 2015) of semiotic resources. I did not give any instructions about the conventions of the genre of scientific diagrams or explanations as this was not the focus. Nevertheless, learners employed generic conventions spontaneously. In Khethiwe's example we see the use of labels, connecting lines between words to show a process and the use of brackets to show alternative expressions of the same substance to aid clarity: 'isoghum beer (umqombothi) utywala'. This shows a good awareness of what the conventions of these genres are.

While drawing and writing are the two broad mode categories employed in Khethiwe's text, within them there are other modes used to express nuances of meaning. The designed trans-semiotising in the activity has produced a highly multimodal text. The drawing part of the text contains two discrete texts: a realistic drawing and a reaction diagram. In the drawing mode

colour and labels are used to convey meaning. In the meshed register (Gibbons, 2006) of the writing, I can trace three source registers: scientific English ('rea(c)tion', 'alcohol'), formal isiXhosa ('iswekile', 'utywala') and Esenginqi, the learners' most familiar language ('isoghum beer', 'iyeast'). Each of the different modes contributes something to the overall meaning of the text: the drawing foregrounds apparatus; the writing foregrounds the human actor and the physical process; the reaction diagram foregrounds the chemical process and the scientific register. If then, Khethiwe were to be restricted to only one mode and register, for example scientific English for explanatory definition, she could draw on the meaning she has made in other modes to create a more comprehensive text. It could be argued too that the most comprehensive text expressing Khethiwe's understanding of chemical reactions at this point would necessarily be multimodal. The activity of explaining what they had drawn gave an authentic context for meaning-making. Working with authentic texts is highly recommended in literacy studies in multilingual environments (cf. Makalela, 2015). The explanations of the diagrams also made 'fixed words' (Lemke, 1990) an impossibility.

For some learners (for example, Yonela) the writing below their diagram was the longest piece of extended writing they completed during the course of studying chemical reactions. Mayaba et al. (2013) found that South African children are exposed to very little writing in the Science classroom. The text-type of reflective explanation proved to be a non-threatening opportunity to track their understanding of a topic at a particular point in time. This text could potentially be reflected upon later as understanding developed.

This activity was novel on two accounts. First, it was a transgressive activity in the incorporation of isiXhosa resources into writing about Science. By taking a trans-semiotic approach, I was able to minimise the threat of writing Science for the first time in isiXhosa by using the diagram as a scaffold. Second, it centred a new genre of writing for Science for these learners: the reflective explanation.

Translating Science

In his 1990 book, Lemke describes a Science class activity which I have not yet come across described in empirical research literature:

> Students should regularly have oral, and occasionally written, practice in class in restating scientific expressions in their own colloquial words, and also in translating colloquial arguments into formal scientific language. (Lemke, 1990, p. 173)

It is the *written* translation activity which has not been reported in school Science literature. Lemke argues that translation exercises can have benefits for increasing 'students' fluency and flexibility in using the foreign register of science' (ibid.) and helping students to understand which register – or purpose-built assemblage of linguistic features - is which. Translation as a linguistic endeavour has traditionally had no place in Science class. This has been assumed to be an activity suited to language classes only. However, the flexibility of expression of the thematic pattern (Lemke, 1990) which translation enables makes it a rich meaning-making activity for Science. Lemke described translations between colloquial English and scientific English. In my study, I had the opportunity to experiment with a translation between scientific isiXhosa, scientific English and colloquial isiXhosa (Esenginqi) – an activity which was transgressive in the light of the English-only language policy of the school.

The current activity took place during the final study group meeting (SG8) which was designed as part focus group, part study group. The first half of the session was dedicated to the interview in which we reflected on the Chemical Reactions unit as studied in the study group and the classroom. Then during the second half, I set up a translation exercise in which the learners worked in pairs. Using a multilingual dictionary of Science and Mathematics terms as a resource (Young, Van Der Vlugt, & Qanya, 2005), I designed a worksheet with key concepts from the topic described in paragraph form. This dictionary exists in multiple copies in the 9B classroom, but Ms B told me she has never used them, indicating that written isiXhosa is not considered a useful tool by Ms B for learning Science in this context. In the dictionary, a concept is defined in English first, then Afrikaans, isiXhosa and lastly isiZulu, with occasional accompanying graphics or diagrams. The order in which the definitions occur is significant in that it indexes a language hierarchy which values English preferentially and then the other three languages in the order in which they appear. On my worksheet, only the isiXhosa definition of each concept was reproduced and a space was left for the learners to fill in an English translation. The translation of one concept from isiXhosa into English comprised the first seatwork activity.

I set up the activity with a critical framing, encouraging the learners to critique both the authors of the sources text ('I want to know how did they do in terms of translating') and the task ('you're the experts'). The learners embarked on the task in a manner which displayed high engagement and interest[43] and early on began making critical comments about the arcane language in which the isiXhosa definitions had been written. Thandile retorted, 'miss, do you realise this is like…deep…deep Zulu'. They also distanced themselves from this register. Yonela explained to me, 'asithi like 'ba formal Xhosa thina' (we don't speak like formal Xhosa).

Yonela and Thandile worked together on the English translation of the definition of 'Imoletyhuli' and produced very similar, but not identical, texts, reproduced below: (The first definition, which appears in the dictionary, was not used by the learners, but here it is used for comparison with the learners' English translations.)

Extract 6.11: Original English, Young et al (2005) (not made available to learners)

> A molecule is the smallest unit of an element or compound that can exist alone; it is made up of the same or different types of atoms, eg. one molecule of water is H_2O; one molecule of hydrogen is H_2 (H_2 is a diatomic molecule – it always exists as two atoms in nature).

Extract 6.12: Original isiXhosa, Young et al (2005)

> Imoletyhuli lelona suntswana lincinci lembumba elinakho ukuzimela; lenziwe ngee-athom zohlobo olunye okanye ezahlukeneyo, umz. Imoletyhuli enye yamanzi ngu-H_2O; eyehayidrojini ngu-H_2 kwaye ihlala izezohayidrojini zimbini endalweni.

Extract 6.13: SG8. Yonela's first version

> A molecule is the smallest part of matter of the compound that can stand or split on its own, as it is made up of one/different kinds of atoms, for example one molecule of water is H_2O, for hydrogen is H_2 and there are always two hydrogens in nature.

[43] On the video, learners are seen leaning in towards their tables and each other and gesticulating during the completion of the task.

Extract 6.14: SG8. Thandile's first version

> A molecule is the smallest part of the compound that can stand or split on its own, as it is made up of one/different kinds of atoms, for example one molecule of H_2O/water has 2 hydrogens and that will stay the same in nature.

The production of these texts demanded rigorous intellectual work and collaboration. Neither Thandile nor Yonela were certain of the meaning of 'isuntswana' (part/particle) and discussed this with the other learners present. Through this they began to develop a receptive register for Science in isiXhosa. The collaboration between Yonela and Thandile was filled with contestation – to be reported on in more detail in Chapter 7 - which then produced more finely tuned conceptual understanding. Following Kress et al. (2014), I argue that the differences in the final texts they produced also revealed their diverging *interests* in creating the texts:

> Students' texts can be read as transformative of the original resources, as their shaping of meaning in what is for them the most apt and plausible way given the resources available to them in a specific context. (Kress et al., 2014, p.29)

The first difference in Yonela and Thandile's translations is found in the first line where Yonela includes in her translation of 'isuntswana' the scientific concept of matter (Extract 6.13). In so doing she produces a register in her translation which is more scientifically technical than Thandile's which omits this term. This references her developed knowledge of the formal isiXhosa word 'isuntswana' as a technical and not an everyday term in this context. The second difference is in the expression of the concept of a water molecule. Yonela renders the section: 'Imoletyhuli enye yamanzi ngu-H_2O; eyehayidrojini ngu-H_2' as 'one molecule of water is H_2O, for hydrogen is H_2 ' and Thandile as 'one molecule of H_2O/water has 2 hydrogens'. Both learners have not accounted for the meaning of the semi-colon between the two phrases and the prefix 'eye' in 'eyehayidrojini'. However, they have also both made scientifically accurate meaning in their translations which focus on the part of the definition which they see as salient for their interest. This centrality of their own interest indicates that

discourse appropriation is occurring (Bakhtin, 1981). Yonela focuses on the diatomic nature of hydrogen in its natural state, while Thandile focuses on the equivalence of the common name and the symbol in reference to the element in question.

Towards the end of the first translation, I began to respond to learners' critiques of the language of the isiXhosa definition by asking them to perform a second translation. This translation was to employ a different register again. Here are my instructions for the pair working on 'atom':

Extract 6.15: SG8. Robyn's instructions

> Robyn: If this is your friend who has never heard English or who never studied science in English you need to write this explanation of an atom, for that person in kasi-Xhosa (township isiXhosa) …So uya-mixa okanya (so you mix or) … but just write the way you'd tell your friend about it

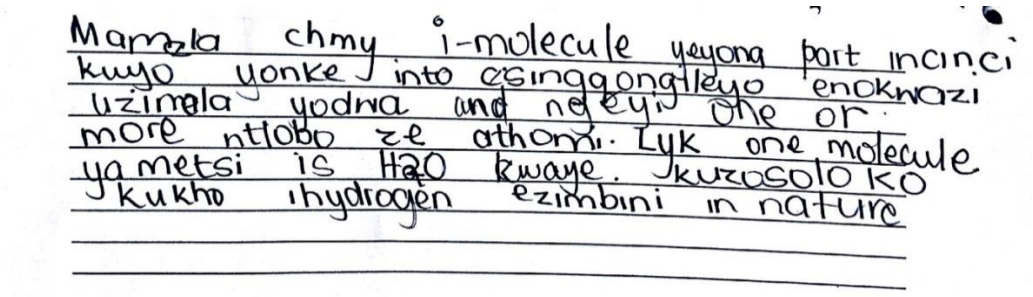
The learners shared ideas and debated vigorously how best to go about making this translation. At one point, Thandile rebelled against the set task and redesigned (Janks, 2004) his own activity (see Extract 6.16, below).

Extract 6.16: SG8. Thandile redesigns the task

> Thandile: You know what's gonna happen now
> I'm not gonna translate this
> I'm gonna write it in my own understanding
> that's what's gonna happen

Thandile's redesigned activity helped to achieve the goal of appropriation of the Science content which was inherent in the activity. Yonela and Thandile's second versions appear below followed by an English gloss.

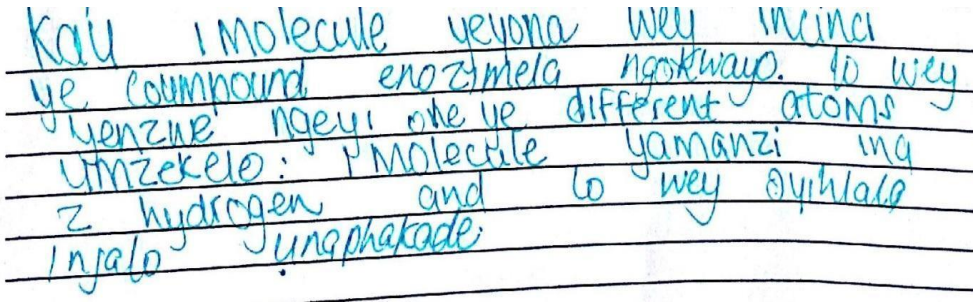
Extract 6.17: SG8. Yonela's second version



English gloss of Yonela's second version:

> Listen my friend, a molecule is the smallest part of all the things which surround us, that is able to stand on its own and it is made up of one or more types of atoms. Like one molecule of water is H2O and there will always be two 'hydrogens' in nature.

Extract 6.18: SG8 Thandile's second version



English gloss of Thandile's second version

> My friend, a molecule is the smallest 'thing' of a compound that is able to stand on its own. This 'thing' is made up of one of the different atoms. For example: a water molecule has 2 hydrogen and that's how it's going to stay forever.

Yonela and Thandile draw on their semiotic repertoires freely and creatively to develop a register for writing Science for the audience of a peer. Both versions are in a highly meshed register in which features of scientific discourse ('atoms', 'compound', 'imolecule') are found alongside social nomenclature ('kau', 'chmy'). Extended written language ('yonke into esingqongileyo') is found with text messaging abbreviations ('chmy', 'lyk'). Sometimes the learners choose features from isiXhosa ('kwaye', 'umzekelo') and sometimes from English

('lyk', 'and') and Yonela includes a feature of Sesotho ('yametsi'). This freedom in drawing on a variety of semiotic features typifies Otheguy, García and Reid's (2015) definition of translanguaging:

> We... define translanguaging as the deployment of a speaker's full linguistic repertoire without regard for watchful adherence to the socially and politically defined boundaries of named (and usually national and state) languages (2015, p.283).

Once again, the choices that the learners make reveal their meaning-making interest. For example, Yonela chooses the phrase 'yonke into esingqongileyo' (everything which surrounds us) aligning with a lifeworld register, whereas Thandile chooses 'compound' aligning with a scientific register.

The learners have now contributed to a total of six written versions of a definition of 'molecule'. These versions offer opportunity for further critical evaluation of the affordances of each for meaning as well as the development of new versions which extend the meaning of these. The nuances of meaning expressed by learners during this exercise as well as their flexible languaging (García & Li Wei, 2014) remain invisible to those who dictate what counts as knowledge by drawing up monolingual and monomodal assessments (Shohamy, 2004). The texts also pose a challenge to arguments made about classroom discourse usually, even optimally, moving from oral home language to written English in content subjects (cf. Setati et al., 2002). Rather in line with previous findings (Tyler, 2016), learners have moved through different registers in a multidirectional manner ending with multiple versions of the Science content.

Teacher as learner

Research in Science education has shown that teachers adopting a learner identity is a powerful activator of learning for students (Hanrahan, 2010). This identity contributes to the fluid and multiple identities which teachers and learners perform in a classroom setting (Makalela, 2014; Makoe & McKinney, 2009). As I have explained in Chapter 3, I embraced the identity position of learner twice over in my fieldwork. I was a learner of both isiXhosa and of

Chemistry and in this identity I was indebted to both the teacher and my fellow learners who taught me. This identity proved indispensable in guided meaning-making.

Metadiscourse of learning

In this section I will show how this learner positioning helped me bring the metadiscourse of learning and studying into the study group meetings in a natural way by:

- modelling reflexive practice
- positioning the learners and myself as scientists
- modelling the positions of not-knowing, getting it wrong and criticality.

Modelling reflexive practice

The first aspect of this metadiscourse is modelling being reflexive as a learner. During the study groups I consciously initiated discussion of our personal study habits in relation to a particular task such as memorising the first 20 elements on the Periodic Table (SG4). We discovered that there were as many ways to memorise these elements as there were people in the study group. I also shared my own study notes with the learners in the study group (SG5), revealing my own problem-solving strategies. Learners' interest in this was high as revealed by minimal responses ('woah!') and the action of leaning in. Finally, I shared something I read in a reference book about Chemistry which helped me towards understanding (SG5). In this way I modelled the use of texts beyond the textbook in learning and that I was on a learning journey just like they were.

Extract 6.19: SG5. Robyn prepares to read from a reference book

> Robyn: I just I was actually just reading in this book about, it's quite nice, it's the basic introduction to chemistry or something, we've been focusing on the periodic table, but but this was just really helpful, it says…

Joint positioning as scientists

The second aspect of metadiscourse which I included in the study groups was positioning the group as a learning community of scientists. Gibbons (2006) found in her study of classes of ESL students in Australia learning Science, that teachers used metalanguage to orientate the

students towards one purpose of learning which is to appropriate the identity of a scientist. She recorded teachers using phrases such as 'we're scientists' and 'talking like scientists' (p.132) to achieve this. I encouraged the learners to investigate their questions about the world, for example, when I urged them to break a pencil in half to see what it was made of. In the following extract, I positioned us as 'chemists' through my language:

Extract 6.20: SG5. We are chemists

> Robyn: we just know that because some other chemists before us they worked it out, And now we have to go back and say well if we want to make CH_4 in our test tube…

Modelling not-knowing, getting it wrong and criticality

I wanted to downplay my identity as a knowledgeable 'Science teacher', as described in Chapter 3, not only because I am not a trained Science teacher, but also to open different opportunities for teaching and learning. I referred to myself as 'a guest of 9B' (SG3) or an 'English teacher' in an attempt to reduce my authority on the topic. In contrast to Ms B who never used the word 'difficult' in relation to the topic, but did frame it as 'easy', I was quick to point to the difficulty and complexity of concepts, using 'difficult' ten times in one study group meeting (SG5). On one occasion saying, 'I find this very difficult' (SG5). In class I once asked a question (C7), weighing up the advantages of positioning myself as a learner with the disadvantages of potentially showing up a flaw in Ms B's reasoning. Apart from the learners' displaying their interest by all turning their gaze towards me while I asked, I was not able to judge whether it was a risk worth taking.

Li Wei (2014) uses the term 'co-learning' to describe practices in classrooms where learners' linguistic repertoires are resources for the teacher's learning, thereby challenging traditional classroom power relations and building a 'genuine community of practice' (Li Wei, 2014, p.186). Whereas there weren't any occasions when I deferred to the learners' better understanding of Chemistry, I certainly deferred to them in isiXhosa. In the extract below, my awareness of the potential for errors in my isiXhosa and my eagerness to learn opened spaces for learners to be 'knowers' and to take up a teacher identity.

Extract 6.21: SG1. Robyn gets it wrong

Turn	Actor/Action	Speech	Gloss
1	Robyn: A few learners still take their seats. Robyn moves hand up high and holds at horizontal.	Ok so our group is full.	
2	Khethiwe	Ja	
3	Robyn: Gaze to Khethiwe sitting to her left Shakes head	Ok. Igruphi yam ihluthi. No	Ok. My group is satiated. No
4	Ls	No. Igcwele.	Full
5	Robyn	Igcwele. Igcwele. Ok.	Full Full. Ok.
6	Thandile: Laughs 2 other learners laugh	Yoh Ihluthi	Oh no Satiated
7	Robyn: Takes out pencil to write. Pats stomach.	Like gcwalisa Not ihluthi hey That's when you've eaten.	Like to fill up not to be satiated hey That's when you've eaten.
8	Ls Khethiwe laughs	Ja.	
9	Robyn: Writing in notebook Khethiwe nods Robyn:	I.gcwele Ok. Igcwe igcwele [ja].	It's full Ok. Is f is full. Ja

In English, the word expressing hunger satiation and the word expressing completeness or maximum volume are homonyms: 'full' and 'full'. In isiXhosa these meanings are expressed by two distinct words - in sound and orthography: 'ihluthi' and 'igcwele'. The incorrect choice of word for my intended meaning caused the learners to correct me (Turn 4) and then enjoy some mirth at the absurdity of my statement (Turn 6). This light moment served to build rapport between the learners and me and allowed them to be 'knowers' in the study group – a role which I reinforced by transcribing the correct word. This transcription also served to model the role of learner for them. The language learning moment was also made more efficient through the use of action (Turn 7). Blackledge and Creese (2017) write of 'translanguaging zones' of which my study group is an example:

> These were spaces where people made fun of each other, laughed with each other, and sometimes became irritated with each other. Most of all, perhaps, they were spaces in which the body was a significant and normative resource for communication in semiotic repertoires. (Blackledge & Creese, 2017, p.267)

By patting my stomach, I was able to efficiently show that I understood that 'ihluthi' relates to digestion and move on to learning the correct word for my meaning. My body became a 'significant and normative resource for communication' (ibid.).

Participating in learner activities

As I have explained in Chapter 4, the make-up of the study group varied from session to session. A group with ten learners lent itself to different activities from those followed in a group with only two learners. The fourth study group comprised myself and only two learners and so the activities were quite informal and followed the learners' interest closely. Following an open question from me half way through the session, Khanyiswa expressed the desire to study ahead in the topic beyond where they were in class. I suggested she 'do a self-study' and my instructions were to 'read all of that and then um, and then try and do that activity' (SG4). The reading which the girls embarked on in the textbook was unprecedented in the class lessons I participated in as I did not observe any set reading of the textbook in class beyond reading the instructions for activities. The content that was written about in the textbook was expounded by the teacher, rather than independently read by the learners. In order to emphasise the value of independent reading, as well as my identity as a learner, I embarked on reading my own book about Science which I brought along to the study group. This guided meaning-making activity provoked many questions from the two girls and could provide a model for how to do independent study in the future. Also, my setting the self-study task positioned the girls as capable independent students.

In her interview, the Principal bemoaned the lack of study skills acquired by the learners at Success High. Her remedy for this included getting the school social worker to run study skills workshops. My approach in SG4 offers an alternative to decontextualized study skills training. Instead, I embedded the skills within very particular content in Science for a particular purpose.

I also participated in the short recall tests of the first 20 elements which we did at the beginning of most study group meetings and the summative test in class at the end of the topic.

Conclusion

In this chapter I have described guided meaning-making and given examples in the data. In this category, learners are encouraged to draw upon a variety of semiotic resources. At times, through official translanguaging (García & Li Wei, 2014) and trans-semiotising (Lin, 2015), they were restricted to particular less-dominant resources for specific purposes such as deepening conceptual understanding. The discourse structure in this category was described as dialogic (Lefstein & Snell, 2011; Mortimer & Scott, 2003). Seatwork tasks constituting guided meaning-making were undertaken with high levels of interest (Kress et al.,2014) being displayed by learners, demonstrated in particular by rich use of gesture. A press (Gibbons, 2006) was exerted on learners' reading and writing skills as extended texts were required to be read and written in guided meaning-making activities.

Certain dispositions of the teacher or facilitator were necessary in order to accomplish guided meaning-making. She needed to become a bystander at times without involving herself in the meaning-making. She needed to reflect critically on the meaning-making that was taking place. She needed to cultivate the position of learner.

The Science meaning which was made by learners in this category was aligned with canonical school Science and expressed flexibly (Lemke, 1990). Learner texts which were produced varied according to their interest. In this way appropriation of Science discourse (Bakhtin, 1981; Ballenger, 2010) was made possible. Skills such as argumentation were developed which are useful for work in subjects across the curriculum. A critical stance towards canonical school Science was taken up by learners through posing questions and redesigning set tasks.

In Chapter 7, I will describe and discuss the last category of meaning-making present in my data: spontaneous meaning-making.

7 Spontaneous meaning-making

> *Learning comes in the cracks when we are open and willing to deal with the uncomfortable conversations, the unpredictable questions, and the spontaneous outbursts.*
>
> - Tolentino, 2007, p.50

Introduction

In this chapter I introduce the category of *spontaneous meaning-making*. Spontaneous meaning-making happens when learners engage with the topic with no intervention, provocation or direct stimulus provided by the teacher or facilitator; when they generate meaning spontaneously, and often playfully, in pursuit of their own interests. We know that this does not mean that learners are free from the interference/contribution of the meanings made by others who have gone before (Bakhtin, 1981), but in a classroom setting I am referring to the kinds of meaning-making which are the most unfettered by the explicit intentions of a teacher, facilitator or guide. When learners chat together about the written work they are doing; when they blurt out a partially-formed question in a whole-class discussion and when they scribble a note in the margin of their workbook, they are engaging in spontaneous meaning-making. Where I have categorised learner contributions following my stimulus as a facilitator as spontaneous meaning-making, it is because the stimulus was given in the manner of dropping a stone into a pond not knowing where the ripples will travel. This is in contrast to the use of a stimulus with the purpose of guiding or constraining meaning-making.

I will argue that in spontaneous meaning-making the learners are frequently achieving more than mere acquisition of the discourse of science; they are appropriating the discourse. Bakhtin argues that a speaker has appropriated a 'word' when he 'populates it with his own intentions' (1981, p.293). I hold that a speaker's (or Science learner's) intentions are equivalent to 'sense-making purposes' (Rosebery et al., 1992) and 'interest' (Kress et al., 2014, p.7) which, when they are expressed, become important litmus tests of appropriation having

occurred. The importance of this appropriation in Science learning is underscored by Rosebery et al. (1992):

> Students must not simply *acquire* scientific ways of doing, reasoning, talking, and valuing; they must also find ways of *appropriating* scientific discourse so that it can serve their own sense-making purposes. (1992, p.67, italics mine)

However, as I argued in Chapter 6, appropriation is often uncomfortable (Kapp, 2004; Brown, 2006) for students for whom the language of Science, 'remain(s) alien, sound(s) foreign' (Bakhtin, 1981, p.294). Further challenges in appropriating the new discourse will become evident in this chapter.

It is in spontaneous meaning-making that the learner's interest is the strongest. Not only does this interest shape the text production (Kress et al., 2014), but in some cases (such as back-channelling in class) it provides the impetus for producing the text in the first place. This is not to say that all learners' spontaneous meaning-making is successful from a school Science perspective[44] (Mortimer & Scott, 2003). At times the meaning they make may be contrary to school Science and I will point out where this is the case. However, it often prods at the cracks in the school Science edifice, trying to prise it open and make it more meaningful or aligned with their lifeworld experience. Whether the meaning which is made spontaneously is successful or unsuccessful from a school Science perspective, the processes which shape this meaning reveal much about learners' interests and the resources they have at their disposal for meaning-making.

Barnes (1992) typology of presentational and exploratory talk is illuminating when studying learners' spontaneous meaning-making. To consider Barnes' two types of learning talk to be discrete entities forming a binary would be to erroneously reduce the complexity of learners' oral meaning-making. However, this typology helps to valourise the kinds of meaning-making I will present in this chapter as fundamental to learning and revealing of learners' cognitive processes. The spontaneous meaning-making in all modes in evidence in my study aligns with exploratory talk in that it is usually 'hesitant and incomplete' (Barnes, 1992, p.126). The

[44] Mortimer and Scott distinguish 'school Science' knowledge from canonical Science knowledge as, in its need to simplify, 'school Science' sometimes reduces canonical Science to the point of contradiction.

semiotic mode as well as register is spontaneously employed by the learner with the least interference from the teacher or other guiding authority. Variations in modes and registers occur as the meaning-making moves between the dominant and subordinate communication channels (Goffman, 1981). When a learner is engaged in spontaneous meaning-making in the dominant channel she will likely be more cognisant of the teacher as audience, whereas when engaging in side-talk (Lemke, 1990) with her friend she will employ any mode or register she chooses. Equally, her awareness of whether or not she is being assessed will influence register choice. When the constraints of assessment or an authoritative audience are removed, learners are free to draw on any semiotic resources that they have in their repertoire. This is 'language in the wild' (Vigmo & Lantz-Andersson, 2014): vivid, creative, playful and sometimes transgressive. It is in spontaneous meaning-making that learners demonstrate register-meshing (Gibbons, 2006) most clearly and therefore pose the greatest challenge to the understanding of registers existing in clearly bounded silos. I will explore how natural and official translanguaging (García & Li Wei, 2014) and trans-semiotising (Lin, 2015) are a core part of the following spontaneous activities which will be featured in the extracts.

Drawing on interactional data from the classroom and study group recordings, the following sections explicate learners' spontaneous meaning-making in the public-talk of the plenary; in peer-to-peer interaction during seatwork; and when learners make meaning in the subordinate channel during plenary discussion. In the examples taken from the plenary, it is the more outspoken learners who will feature: Asanda, Thandile, Khethiwe and Mthobeli. During seatwork in groups, which is a more private space, we hear the voices of Mbulelo and Mandla who did not volunteer in the plenary.

Learner contributions to plenary

Learners engaged spontaneously in the plenary setting of both the classroom and study group. In the examples below I consider spontaneous meaning-making while engaging with the teacher/facilitator, with peers and while back-channelling[45].

[45] Back-channeling refers to the communicative behaviour of the audience of a podium event (Goffman, 1981) or plenary where one message animator dominates the verbal discourse but the receivers contribute multimodally through a different channel.

Engaging the teacher/facilitator in the plenary

Spontaneous engagements with a teacher or facilitator typically take the form of a question. Lemke (1990) holds that this 'student-questioning dialogue' is a rare classroom activity. This was certainly the case in my study. A learner question was a rare thing and sometimes served as a catalyst for further questions from other learners, producing a phenomenon of clustering of questions, as described in Lemke's study (1990, p.52). As space opens up for conceptual challenge and lack of understanding or learner interest to be aired, learners embrace it and questions abound. On occasion (eg. in C7) this extended into engagement with peers through cross-discussion: questions and answers between learners without the teacher as mediator (Lemke, 1990). The responses to learner questions by the teacher or myself as facilitator varied, as shall be seen in the extracts.

As described in Chapter 6 Chin (2001) (as cited in Alvermann, 2004), distinguishes between *basic information* and *wonderment* questions asked by learners. Teachers find wonderment questions challenging as they require them to first understand the thought processes that initiated the question. In the following extract from her playback interview Ms B reflects on the kinds of questions that different learners ask.

Extract 7.1: Teacher Interview 2. Learner questions.

> Ms B: Yonela I never have a problem with
> the questions she
> she's usually clear (Robyn: clear)
> ja what she needs to know
> but um Asanda not so much
> I think she .
> ja I I usually struggle to understand what she's asking
> and Bongeka is worse
> I can never understand what Bongeka is saying

Yonela whose questions are 'clear' to Ms B usually asks basic information questions and Asanda and Bongeka usually ask wonderment questions which are those Ms B 'struggle(s) to understand'. Ms B begins to place the locus of misunderstanding with Asanda ('I think she') but backtracks on this and places it on herself ('I usually struggle to understand'). Perhaps this is so that she does not appear condescending or critical of one of her learners to me as

researcher. Ms B's discomfort with Asanda's wonderment questions is evident in the extract from a class lesson below. It follows an episode of triadic discourse on the sub-topic 'naming compounds'.

Extract 7.2: C3. Asanda's wonderment question

Turn	**Actor/action**	**Speech**	**Gloss**
1	Asanda:	miss can I ask you something	
2	T:	Yes	
3	Asanda: T approaches Asanda and stands about 3 m from her facing her.	If if . if it happens that um . the the the compound formula doesn't have i- a a a a ele an element that's that's that's not a metal kwenzeka ntoni	If if. if it happens that um. the the the compound formula doesn't have a- a a a a ele an element that's that's that's not a metal what happens then
4	T: Turns away from Asanda towards the whiteboard	<FAST> usually_does <FAST> remember I told you the other day	
5	Asanda:	//but//	
6	T:	//that um//	
7	Asanda:	but but i-hydrogen and oxygen…	

Unfortunately, the camera's view did not extend to where Asanda was seated during this lesson, so there is no action data for her question. I observed that exploratory talk of this nature is usually complemented by meaning-making in actional modes. Asanda's question is uttered in a meshed register which employs translanguaging to make meaning. She draws on features of 'isiXhosa' ('kwenzeka ntoni') and 'English' ('something') and technical terms from the topic ('compound'). Her exploratory utterance is halting and hesitant (she pauses and restarts) as she orders her thoughts. Ultimately, she poses an exception to the rule of naming compounds which Ms B has been positing. The question is challenging due to its exploratory

nature and its challenge to the rule which Ms B has been teaching about how to name compounds.

Ms B's response to Asanda's question is conflicted. She initially demonstrates an interest in Asanda's question by approaching her physically (Turn 3). She then attempts to avoid the question in Turn 4 by using 'usually', speaking quickly and physically moving back towards the authority of the whiteboard and her own words spoken in the past 'remember I told you', as well as to a standard 'English' which is associated with the authority of the test and textbook. These features constitute constrained meaning-making on the part of the teacher in that she is trying to shut down the question. However, she then allows Asanda to interrupt with an elaboration on the question (Turn 5 and 7). Asanda re-asserts her interest through objecting ('but') to Ms B's diversion by providing a correct example of a compound consisting of hydrogen and oxygen, neither of which is a metal. She also re-introduces the meshed register, including the Xhosalised 'i-hydrogen' which is more familiar to her. In this way she resists the constraining meaning-making of the teacher.

In the example of a spontaneous question asked in the plenary which follows, a learner again employs a familiar register to introduce a wonderment question.

Extract 7.3: C7. Mthobeli's wonderment question

Turn	**Actor/Action**	**Speech**	**Gloss**
1	Mbulelo: (Points to Mthobeli)	Miss, uMthobeli uyabuza.	Miss, Mthobeli is asking
2	Mthobeli: smiling	Xa i-element i-radioactive ithetha 'ba ithini	When the element is radioactive what does it mean
3	L	ithini?	what?
4	Mthobeli:	It is radioactive	
5	Thandile	Rediactive Reactive	
6	Ms B: Raises hand with fingers splayed and palm facing towards Mthobeli	Ok	
7	Mbulelo:	Radioactive.	

8	Thandile:	Rediactive	
9	Khethiwe:	Like a radio.	
10	Ls and Ms B:	(laughter and clapping)	
11	Ms B: Turns towards the board with hand raised again towards Mthobeli in same gesture. Begins to rub writing off the board.	Mthobeli masingayenzi apha neh I will explain to you but I don't want to Ok people now	Mthobeli let's not do it here right I will explain to you but I don't want to Ok people now

Moments before Mthobeli's question is asked, Mbulelo and Thandile are talking about the word 'radioactive' and Thandile gestures from Mbulelo towards Ms B, indicating that he should ask her the question. This constitutes an important function of side-talk as Lemke (1990) has observed:

> Side-talk serves students' needs to talk with someone other than the teacher about what is going on at the moment in the class… Students first share their question, or confusion, or idea with another student, and only then do they go public with it and ask the teacher. Students…get very little practice speaking the language of science. Just to phrase a question they need to get a running start, and dialogue is the practice ground… (Lemke, 1990, p.75)

The function of side-talk as a rehearsal of Science language is particularly evident in this example. For at least a minute before this extract, Mbulelo, Mthobeli and Thandile have been discussing the word 'radioactive' concurrently with the dominant communication channel of the student-questioning dialogue. Mbulelo has said to Mthobeli, 'Buza Miss. It's important' (Ask Miss. It's important). Then Mthobeli begins to rehearse the question: 'Ndithi what does it' (I say what does it) followed by Mbulelo's rephrasing, 'What does the word radioactive mean'. Then Mbulelo, who is interested in the question of radioactivity gets the teacher's attention orally and sets Mthobeli up as the questioner and someone who runs the risk of losing face if the question is deemed to show him in a bad light in any way. This face-saving technique is typical of Mbulelo's identity work in general where he often moves to put himself in a superior position in relation to his peers. Mthobeli's smile may indicate that he realises he's been set up but he goes ahead with the question anyway. Natural translanguaging plays

an important role in providing three versions of the question with which Mthobeli eventually 'goes public'. He begins by phrasing the question haltingly in a familiar register. Mbulelo then builds on this expression and produces a version of the question in 'scientific English'. Mthobeli then publically expresses a well-formed question in a meshed register of isiXhosa and English. This use of familiar register in these two examples converges with the learners' interest which the questions pursue. The converse is also possible: if learners are denied the opportunity to use their most familiar registers, their wonderment questions may also be suppressed. As with Asanda's question, Ms B avoids addressing Mthobeli's question directly, thereby retaining her identity as a knower, but not embracing the identity of learner in engaging with uncertainty. Mthobeli's related, but not curriculum-compliant question, presents a dilemma for Ms B as she expresses in her second interview:

Extract 7.4: Teacher Interview 2. Learner questions continued.

> Ms B: and it's actually really nice that they asking them
> cos you know at least they think about it
> but now it gets
> it like
> it becomes challenging
> in that you need to control
> like your answers
> and um
> answer what they asking
> and answer what you what they should learn in Grade 9
> you understand

Ms B here sets up a tension between the value of learners 'think(ing) about' the topic as expressed in their questions and 'what they should learn in Grade 9'. This is a real dilemma for her, emphasised by her solidarity move towards me in her final utterance, 'you understand'. In her explanation Ms B introduces the constraints of the CAPS curriculum as a limiting factor on wonderment questions. The curriculum is constrained in terms of what must be covered in what sequence and also how much time should be spent on each topic.

Having presented two wonderment questions asked in the class setting, I now present an episode in the study group which was dense with learner questions and exclamations with regard to the topic. During the seventh study group meeting, I had been relating the particle

model of matter to the objects surrounding us in the library in order to explain the difference between an atom and an element. The extract below is from this discussion.

Extract 7.5: SG7. Wonderment questions and exclamations in the study group

Turn	**Actor/Action**	**Speech**	**Gloss**
1	Robyn Ls engage in side-talk	everything here is atoms. everything we can grab the atom	
2	Nomsa	Are we atoms?	
3	Khethiwe	So the element	
4	Robyn Pages through notebook, side talk stops	We made of atoms we are made of atoms where's Thandile where's Thandile's question let's find Thandile we need to tell him about this question Thandile asked: is everything around me made of atoms?	
5	Asanda	**Yees**	
6	Robyn	<SLOW> Absolutely everything </SLOW>	
7	Nomvuyo	Even the even the paper?	
8	Khethiwe, laughing	uthi yees (she said yees)	
9	Nomvuyo	<SLOW> It's very hard to believe </SLOW>	
10	Khethiwe	**//So an element describe a kind of atom//**	
11	Nomsa	**//Miss//**	
12	Asanda	**//Has it been proven** **has it been proven scientifically//**	
13	Fezeka	Miss even food	
14	laughter		
15	Asanda	Oh no this is not real	
16	Khethiwe, laughing	**I'm eating atoms** **oh my word**	
17	Fezeka	**Yoh we even eating**	
18	Robyn	**What did you think it was**	
19	Nomvuyo	Hayi man	No man
20	Nomsa	And Miss Miss	
21	Asanda	**I thought it's** **ii-atoms** **we only find** **atoms** //in substances like metal	**I thought it's atoms** **we only find atoms** //in substances like metal

		you know//	you know//
22	Khethiwe	//In in like//	
23	Nomsa	**//Miss Science is so interesting//**	

Prior to this extract, we had been revisiting learners' written questions which were described in Chapter 6. One learner picked up on a written question I had read out and asked a follow-up clarification question which led to more learner questions. This extract represents the height of learner interest in the study group meeting which is made clear in the discourse as follows.[46] The episode is dense with learners' wonderment questions: 'Are we atoms?', 'Even the . even the paper?', 'has it been proven scientifically?', 'Miss, even food?' which often overlap. Centering learner questions as a context for meaning-making has created a flood of interest in the topic. The questions uttered here are exploratory and based in the lifeworld experience of the learners. They refer to concrete things 'we', 'food', 'the paper', some of which are present and are touched by the speakers. The meaning is made here by moving from the generalised scientific theory of the particle model of matter into the specifics of what this means for everyday objects in their world. The conflict of this new meaning with their established worldviews is expressed by the learners in their interjections: 'it's very hard to believe', 'oh no this is not real', 'I'm eating atoms, oh my word', 'we even eating'. However, the new meaning of 'atom' has also piqued their interest, as evidenced by the density of wonderment questions and the rising tone and volume of many of the utterances, including my own, which is also expressed through the genuine question: 'What did you think it was?' focusing on the learners' prior knowledge and drawing attention to a shift in understanding.

Engaging peers in the plenary

When learners engage in cross-discussion, they take up great agency. In these moments they are engaging in the academic topic with the teacher and their peers as the audience, but with a high level of interest as they are addressing their peers on the topic at a moment of their choosing. In contrast to the constrained meaning-making which is necessitated by strict

[46] Video data is not available as the video recording failed in this meeting.

triadic discourse, learners engaging in cross-discussion set the agenda and employ features of their semiotic repertoire that serve their interests.

The first example of a cross-discussion is taken from the study group data set. We were discussing why it is necessary to balance chemical equations. In this discussion I spoke about the law of conservation of matter which states that matter cannot be created or destroyed but only changed, even at the atomic level (Bester et al., 2013).

Extract 7.6: SG5. Khanyiswa in cross-discussion[47]

Turn	**Actor/ Action**	**Speech**	**Gloss**
1	Robyn: writing	this is a great question how do you make elements if you can't um . make atoms and this is um the conservation	
2	Khanyiswa	law of conservation	
3	Robyn	What is called. ja	
4	Nomvuyo	Yintoni leyo?	What's that?
5	Robyn	conservation of matter conservation of	
6	Khethiwe	//now what you are talking about//	
7	Robyn	//I'll just check what// that the the fact that you can't you don't lose or gain atoms during reactions	
8	Khanyiswa	mm okanye	mm or
9	Robyn	You don't lose them or gain them they just reconfigure	
10	Khanyiswa	and awukwazi uzenza but you can transfer like u-tshi uzi-tshintshi like you can like i- i-potential energy ukuyenza ebe yi-kinetic	and you can't make them but you can transfer like you can ch- you change them like you can like um potential energy you can make into kinetic
11	Robyn	mm	

[47] Video data is not available for this extract as the camera battery failed after 48 minutes.

In response to Khethiwe's question 'now what you are talking about' (Turn 6), Khanyiswa diverts the respondent from me to herself and embarks on an explanation of the law of conservation of matter in order to help Khethiwe. Khanyiswa employs features of both a familiar social register and a scientific register in order to construct a scientific explanation ultimately producing a meshed register (Gibbons, 2006). It is a pity that there is no video data available because I imagine that gesture helped Khanyiswa to convey the message. The same process is at work here in Khanyiswa's discourse with features such as 'like' being associated with an oral everyday register and 'i-potential energy' being associated with a formal scientific register. She speaks what Lemke describes below as an 'interlanguage':

> Students will begin to grasp semantic and conceptual relationships in colloquial language first. Then they will substitute scientific, technical terms for colloquial words. Only much later will they be able to speak "pure science". Along the way their version of scientific language will be an "interlanguage", a sort of hybrid of colloquial and technical registers.'(Lemke, 1990, p. 173)

I designate Lemke's "interlanguage" as a pejorative term, placing utterances such as Khanyiswa's in a linguistic no-man's-land, and welcome his use of scare quotes for this term and "pure science". I argue that the scare quotes point towards the implausibility of defining registers as clearly as Lemke does. Instead, I regard registers as inherently heteroglossic, following Bakhtin (1981), and seek to identify how features of different semiotic varieties interact in the utterance and contribute, or not, to learning. An analysis of Khanyiswa's utterance in Turn 10 above points towards this heteroglossia. She uses the simple present tense ('and awukwazi uzenza') which indicates a universally applicable rule indicative of a scientific voice. Her explanation is also lexically dense – 'transfer', 'change', 'potential energy', 'kinetic'. She uses connectives to work through her explanation step-wise ('or', 'and', 'but', 'like'), linking the concept of the conservation of matter to the concept of the conservation of energy in the style of an argument. She begins to achieve a level of abstraction, which is valued in scientific discourse, through the use of the indefinite second person pronoun 'you'/'u'. That this bilingual utterance is spontaneous means that Khanyiswa is less likely to fall into the trap of merely reciting 'fixed words' (Lemke, 1990, p.91) such as those that would appear in a written explanatory definition of the law of conservation. The cognitive benefits of flexible wordings rather than fixed words are lauded by Lemke:

> In teaching Science, or any subject, we do not want students to simply parrot back the *words*. We want them to be able to construct the essential *meanings* in their own words, and in slightly different words as the situation may require. Fixed words are useless. Wordings must change flexibly to meet the needs of the argument, problem, use, or application of the moment. (1990, p.91)

Khanyiswa is breaking new conceptual ground with this utterance. She links the law of the conservation of matter to the law of the conservation of energy. Her explanation is not easily understood by her peers as suggested through their minimal responses to Khanyiswa's explanation which follow this extract such as 'h^{hm}'– an indication that it is a complex idea. Her explanation makes me wonder whether it would have been possible had she been limited to English only in this moment. Her translanguaging here supports García and Li Wei's assertion that it can allow learners to 'truly show what they know' (2014, p.80).

This spontaneous text which Khanyiswa creates holds rich potential for further elaboration on the concept of conservation of matter and therefore deeper understanding for Khanyiswa and her peers. Owing to my limited proficiency in Khanyiswa's familiar register as well as my intention to remain in control of the discourse, I did not invite further elaboration at this time. My 'mm' (Turn 11) ratified Khanyiswa's contribution and I moved to further explain the law of conservation.

The second example of learners engaging in cross-discussion occurs when, in Class 7, Thandile highjacks the teacher's turn and responds to Bongeka's teacher-directed question opening up the space for further cross-discussion including Asanda. The class has been discussing the charges of different elements on the Periodic Table, including Carbon which has four electrons in its outer shell which may participate in a reaction. The learners are struggling to understand when atoms will lose or gain electrons in reactions. In the case of Carbon, it will depend on which element it is reacting with. Ms B has drawn some Bohr diagrams showing the electrons on the outer shell of different atoms on the board (Figure 7.1).

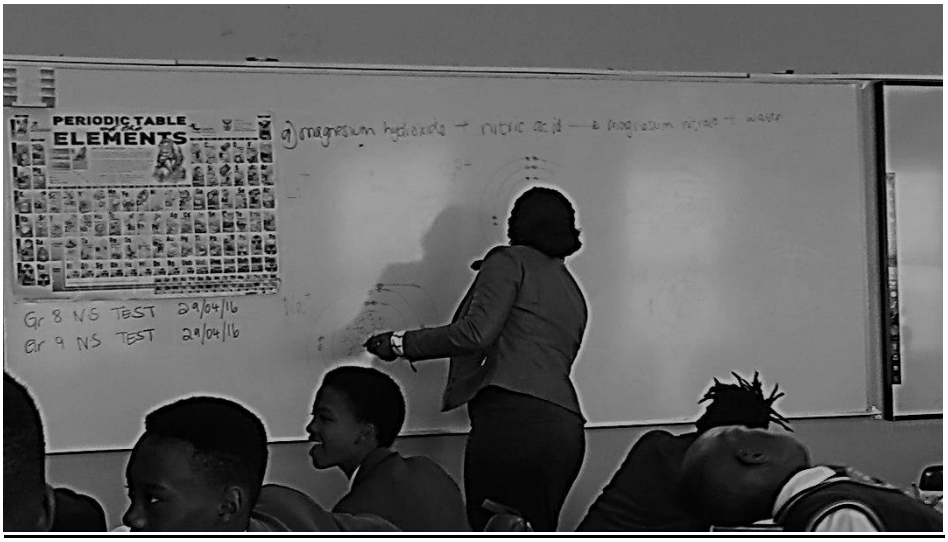


Figure 7.1: C7. Photograph of Ms B writing on the board mid-way through the lesson depicting Bohr diagrams of atoms (centre) and poster of the Periodic Table (left)

The extract of the cross-discussion begins below with Bongeka's question.

Extract 7.7: C7. Thandile and Asanda take the floor

Turn	**Actor/ Action**	**Speech**	**Gloss**
1	Bongeka: Points in front of her Thandile, Asanda and Ms B gaze at Bongeka	Miss ndicel' ubuza ukuba ibiku4 ke ngoku ibizothini?	Miss I'd like to ask if it was in 4 now what would it do?
2	Thandile: Moves arm and gaze from Bongeka to the board and back	//Still ibizoluza // because kushota six	Still it would lose because 6 are missing
3	Asanda: Gaze towards board Turns head to gaze at Thandile, eyes widen.	//na na// A-a. If ukuba bekukhwi4, if ukuba bekukhwi4 kwi-outer line then ke ngoku izoxhomekeka – as uba uMiss ebesandotsho ngoku ngoku	It would it would No-o. If if there were 4, if if there were 4 in the outer line then now it will depend – as Miss just said now now

	Holds up 4 fingers. Looks to Bongeka Thandile holds finger at mouth and frowns	izoxhomekeka nge… nakwi…	it will depend on… and on the…
4	Ls	Element.	
5	Asanda: Gaze towards Bongeka Hand holding pen points at Periodic Table on the board. Thandile gazes towards Bongeka Bongeka gazes towards board	…i-element enayo. Ja.	The element it has. Yes.

Thandile boldly usurps the floor to give an answer using an informal familiar register appropriate to a conversation with a peer, such as Bongeka. I argue that this usurpation emboldens Asanda to join in with a flat rebuttal of Thandile's answer. She goes on to build a more nuanced and accurate argument. Together Thandile and Asanda produce an oral explanation using genre conventions such as connectives of causality ('if ukuba…then ke ngoku'), scientific lexis ('element') and intertextual reference to other parts of the explanation ('as uba uMiss ebesandotsho ngoku ngoku'/as Miss just said now now).

This instance of spontaneous meaning-making, ushered in by Bongeka's question has opened up a collaborative space in which learners generate a better explanation by building on each other's contributions. The collaboration is also engendered through gaze and gesture. Lefstein and Snell (2011) have argued that the direction of gaze indicates interest and attention in classroom participants. In Turns 3 and 5 in particular, Asanda and Thandile show care for Bongeka's understanding through directing their gaze to her and connecting her with the boardwork through gesturing towards it. Other learners gaze variously at Bongeka, Asanda, the board or their exercise books. No learner's gaze is towards Ms B. She has become a peripheral participant in this episode.

Back-channelling

Back-channelling can be a useful way for learners to keep in conversational touch with the teacher (Cazden, 1988). Furthermore, conversation analysts Tolins and Fox Tree (2014) found that addressees can influence story tellers by using back-channelling with the result that story tellers either provide discourse-new events when addressees display understanding and continued attention through *generic back-channels*, or that they elaborate on previously presented events when addressees respond to the content of the previous turn through *specific back-channels*. In the learning spaces of Success High, I found that learners could influence the teacher or facilitator's input in a similar way.

One of my key participants, Khethiwe, was a regular employer of back-channelling. As her conversation partner in the study group I can attest to how her 'm-hm's and 'yho's kept me in touch with her during conversation. Like Tolins and Fox Tree (2014), I found that this had an influence on my input and directed it more towards her interest. It is likely that this practice has influenced Khethiwe's position as the most successful Natural Science learner in her class. To corroborate this, Khanyiswa, another high achieving Natural Science learner in one of the other Grade 9 classes, also employed back-channelling extensively.

To demonstrate this in action I draw my first example from the third study group meeting in which Khethiwe and myself were participants along with three other girls. At the time I had just embarked on an exposition of how scientists discovered four new elements recently. This exposition is realised through a monologue, interspersed by Khethiwe's back-channelling.

Extract 7.8: SG3. Back-channeling which influences the speaker

Turn	Actor/Action	Speech
1	Robyn	this book was printed before um wh-uh must have been more than two years ago so it's out of date
2	Khethiwe	m: m
3	Robyn: Gaze moves quickly from my textbook to each learner to their textbooks Gaze to Khethiwe, the only 9B member present	So those those six elements were once just theoretical two of them were found and and have been named and then in class today we were talking about the other four

4	Khethiwe	m:
5	Robyn Gaze moves quickly from my textbook to each learner to their textbooks	So what scientists have done is that they've said if if we find an element that is 115 that that has an atomic mass of 115 <FAST> sorry not an atomic mass an atomic </FAST> //number//
6	Khethiwe	<SLOW>//number//
7	Robyn gaze at Khethiwe	Ok <FAST> **so the number of electrons and protons** </FAST> it would it would fit here in the table.

Although Khethiwe's contributions in Extract 7.8 cannot be theoretically construed as turns, I have labelled them as such for practical purposes to be able to refer to her contributions easily. In Turns 2 and 4 Khethiwe's *generic* minimal responses are confirmations which are more (T2) or less (T4) audible and assertive. They have the effect of displaying understanding and continued attention. They also mark pauses in my exposition as evidenced by the 'so' which follows each of Khethiwe's responses. Whether this back-channelling causes the pause or is caused by it is impossible to argue from the data. However, their synchronicity enables Khethiwe to reinforce the end of one section of the exposition and the beginning of another for her own understanding as well as keeping in conversational touch with me.

Her *specific* back-channel in Turn 6 responds to the content of Turn 5 and, in Turn 7, I elaborate on the previous turn by providing a definition of atomic number while casting my gaze towards Khethiwe. The combination of my gaze shift and the elaboration on my corrected previous utterance is evidence of the effect of Khethiwe's back-channelling on me as dominant speaker. Her back-channelling has influenced my next utterance.

What a wonderful thing it is when learners express spontaneous interest in an academic topic through a back-channel. It is a sign to the teacher or facilitator that this learner is, at this moment, fully engaged in the lesson: the proverbial light bulb has gone on. Using their most familiar register, the Success High learners were able to give vent to their emotions of surprise through their specific back-channels. Extract 7.9 shows Mthobeli doing just that.

Extract 7.9: C1. Mthobeli's exclamation

Turn	Actor/Action	Speech
1	Ms B	Ok So u: m <FAST> we're looking at </FAST> these are all our known elements. there are like <FAST> 115 of them </FAST>
2	Mthobeli	Yho!
3	Ms B	And they are arranged in groups and in periods

The increased pace of Ms B's utterance in Turn 1 '115 of them' suggests that the number of elements is a piece of knowledge that is relatively insignificant in her exposition. It is possible that she assumed the learners had already grasped this fact given that the Periodic Table is displayed on the board in full view. However, Mthobeli's response cry[48] (Goffman, 1981) suggests surprise and awe at this number, indicating his high interest in this.

Another example of back-channelling which was used by learners to respond affectively to the current content of the lesson was produced in Class 3 (Extract 7.10). Ms B, in response to a question by Yonela, has just finished explaining a rule which governs how compounds are made. This rule has appeared on the board, written in academic English, since the beginning of the lesson and has been explained, in academic English, by Ms B earlier.

Extract 7.10: C3. Bhided by George

Turn	Actor/Action	Speech	Gloss
1	Many learners: Ms B turns back to the board	O:h	
2	Ms B turns back slowly to face learners		
3	Fewer learners: louder	**O:h**	
4	Ms B	So you didn't get that till now	
5	Ls	Yes	
6	Ms B	Rea:lly	
7	Thandile	We did miss qha u-explaina more	We did miss only you explained more
8	Ms B	//yes//	

[48] Goffman (1981) describes those contributions to communication which serve to elicit a response rather than a reply by way of speech. They can also serve as self-management in talk (p.136).

	Looking at learner who has her hand up		
9	Onke	*//we were // bhided by George*	We were confused by English
10	Ls	m:m	

Ms B's surprise expressed in Turn 1 positions learners as having been slow to understand. Thandile immediately springs to the defence of the class in Turn 7, fingering Ms B's explanation rather than their understanding as the problem. In so doing Thandile reaffirms the identity of all the members of the class as able Science learners. Onke's remark which ends the extract picks up the playful mood with which the extract opens – especially Turn 3 in which some learners exaggerate a previous utterance for dramatic effect in response to Ms B's dramatic action of turning slowly to face them. Onke's back-channelling in Turn 9 (which is probably not heard by Ms B as it was indistinct on the audio recording of her voice) positions the class as victims, not of the teacher's explanation, but of the language, English, personified by the name 'George'. Onke's remark unites the class as emergent bilinguals who sometimes find academic English confusing. This use of personification of the English language was referred to by the two student teachers I supervised during my fieldwork. They told me how they had heard one of the teachers at the school use the expression 'uGeorge' when working with particularly dense academic English in his lesson. They admired this practice as they found it built rapport with the learners, showing them that they faced a 'common threat' (fieldnotes, 140416). The choice of the name George was purported to be a reference to King George of England. This personification coupled with the innovative translanguaging ('bhided') through Anglicisation of the isiXhosa word 'ukubhideka' (confusion) is evidence of a playful and affectively releasing utterance[49]. It is part of what Goffman (1961) describes as the underlife[50] (as cited in Guitterez, Rymes & Larson, 1995, p.451) of the classroom in which learners give voice to the pressures of learning content through a language they do not have complete mastery over.

[49] See Tyler 2016 for another example of this kind of cathartic moment in a bilingual learning environment.
[50] Underlife is described by Goffman as the 'range of activities people develop to distance themselves from the surrounding institution' (Guiterrez et al, 1995, p.451)

Engaging with peers during seatwork

The second arena in which learners engage in spontaneous meaning-making is in constrained seatwork exercises. These pen-and-paper activities completed whilst seated at their desks were almost exclusively drawn from the set textbook and comprised closed questions which demanded short written answers. Of the 472 minutes of topic-specific time in the class lessons, 130 minutes (or 30%) were dedicated to this activity (see Figure 6.1). As the teacher did not insist on silent individual work, only that each learner completed the exercises, this activity provided ample opportunity for learners to engage with each other in conversation. Much to the teacher's surprise this talk was often about the science topic of study. In a fieldnote I wrote I recorded a conversation we had about this:

Extract 7.11: Fieldnotes about seat-talk 120416

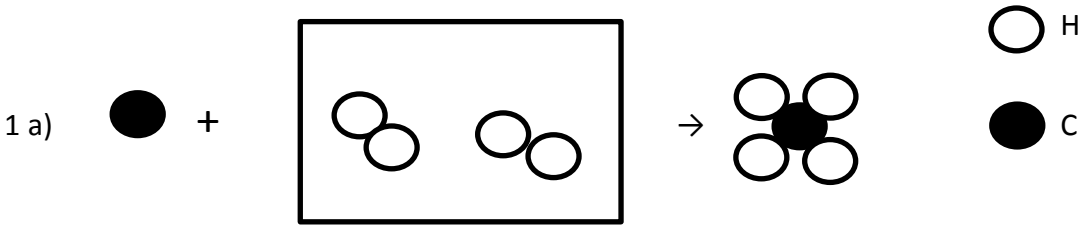
> Ms B was also interested that I was collecting voice data from learners. She said that she assumes they are just talking about social stuff. A reason given is that she said today they were so alive!

With the goal of completing a constrained or guided seatwork activity as accurately and quickly as possible, learners share ideas and request help from each other using their shared, familiar register.

Becoming the teacher

The extract below features the group of four boys who sat at a table with an audio recorder positioned in the middle. They are working on an activity in the textbook in which they are required to 'read' a series of coloured circles as atoms belonging to different elements in a reaction and translate this into an equation representing the reaction using chemical symbols. Mthobeli begins to talk through the procedure of representing the diagram of two hydrogen atoms in symbolic form. Then Mbulelo experiences a breakthrough in his understanding of diatomic elements and shares this with the group. He has been problem-solving by reading an explanation of diatomic elements in the textbook on the opposite page to the activity they are working on. It gives him insight into how they should represent the four white circles

(enclosed in a box here for ease of reference) from the question reproduced below in chemical symbols.



Extract 7.12: C4. Becoming the teacher

Turn	**Actor/Action**	**Speech**	**Gloss**
1	Mthobeli	Uqale ubhale apha ugqibe uthi four Hydrogen nton' nton'	You first write here then you say four Hydrogen what what
2	Mandla	Apho oh andiyibonanga	There oh I didn't see it
3	Mbulelo	Na-na-na! (singing)	
4	Mthobeli	(indistinct)	
5	Mbulelo Looking from exercise to definition of 'diatomic elements' on opposite page Tapping Mthobeli's hand with his pen Pointing with his pen back to the explanation in his textbook then to the activity in Mthobeli's and back again	Oh ha-a (indistinct) jonga, jonga	Oh no no Look look
6	Mthobeli	Mh?	
7	Mbulelo Points to the activity in Mthobeli's textbook Holds his finger on the description of 'diatomic elements' in his own textbook and points with	Kaloku jonga uyabona kaloku iHydrogen iyimolecule yona i-exista zibayitwo zona xa iexistayo, so awuzibali ziyifour zona apha ziyitwo zicounta as two because iHydrogen	But look you see then the Hydrogen is a molecule that exists, they are two when they exist, so you don't count them as four here they are two, they count as two because Hydrogen

	his pen at the activity in Mthobeli's textbook	xa iyi-one udibanise i-Oxygen	when there is one and you add Oxygen
8	Mthobeli Closing fingers and thumb to make the shape of a circle	Ayisoze iHydrogen ibeyi-one	Hydrogen can never be one
9	Mbulelo	Ewe so ubhala two apha so awuzubhala four	Yes so you write two here so you're not gonna write four
10	Mthobeli Pointing at Mbulelo	Ubungatsho ngani?	Why didn't you say so
11	Mbulelo Pointing at Mthobeli	Ubungatsho ngani?	Why didn't you say so

Mbulelo is clearly excited that he has discovered how to continue with the activity. He is insistent that Mthobeli 'look' and listen to him. He then embarks on a multimodal explanation using both his and Mthobeli's textbook and his most familiar meshed register to argue that they should not represent the four hydrogen atoms together as four. In Turn 7, Mbulelo draws two texts together through the use of gesture indicating that one has bearing on the other. This flurry of gestural activity is in contrast to the static nature of all the boys' bodies up to now. Goldin-Meadow (1999) (as cited in Roth, 2004) has shown physical gestures 'used in conjunction with spoken utterances represent the leading edge of cognitive development' (Roth, 2004, p.48) ie. that gestures express understandings which cannot be expressed yet in spoken words. In the case of Mbulelo, his gestures and gaze connect the current activity with the notion of a diatomic element before he begins to express this in words to Mthobeli. The interaction ends with Mthobeli and Mbulelo jostling for position as the most helpful or knowledgeable peer in the group, a one-upmanship pattern which played out in every lesson within this group. This is an example of what Ballenger describes as 'the social intentions remain enmeshed in the arguing and theorising' (Ballenger, 2010, p.10) enabling multiple identities to be enacted simultaneously. Mbulelo has argued convincingly for the relevance of the theory of diatomic elements to the current activity while at the same time trying to demonstrate to his friends that he is of superior intelligence to them.

Contesting knowledge

In Chapter 6 I discussed an activity in which learners were engaged in the study group in guided meaning-making. I gave each pair of learners a definition of a topical Science term in isiXhosa and asked them to translate it, firstly into English and then into their familiar social register. In the process of completing this activity the pairs engaged in debate about how to do the translations. This metalinguistic exploratory talk proved productive for spontaneous meaning-making. The learners were energetically engaged in the translation exercise. This interest was visible in the video footage where learners can be seen leaning forward towards the printed text, talking animatedly, rocking back in their chair rapidly while smiling and exclaiming 'yhu!' ('wow!'). Learners at times entered into the discussion with other pairs if they felt they could contribute to translating a part of another's definition. The task was difficult, but interesting and highly collaborative. In the analysis below, I take extracts from Yonela and Thandile's discussion during the making of translations of the term 'molecule'.

The source text definition is reproduced below:

Extract 7.13: isiXhosa, Young et al., 2005, p. 152

> Imoletyhuli lelona suntswana lincinci lembumba elinakho ukuzimela; lenziwe ngee-athom zohlobo olunye okanye ezahlukeneyo, umz. Imoletyhuli enye yamanzi ngu-H2O; eyehayidrojini ngu-H2 kwaye ihlala izezohayidrojini zimbini endalweni.

Appropriation through argument

The underlined phrase in the second line of the definition caused much consternation between Thandile and Yonela. As alluded to in Chapter 6, Thandile sees a conceptual error in rendering 'Imoletyhuli enye yamanzi ngu-H2O' as 'one molecule of water is H2O'. He objects to what he sees as the use of a synonym, as he expresses in Turn 1 below:

Extract 7.14: SG8. Water and H_2O

Turn	Actor/Action	Speech	Gloss
1	Thandile: reading	Water H_2O it's the same thing For example one molecule one molecule of H_2O of H_2O	
2	Yonela	Hayibo	

3	Thandile	Ewe phakathi not of of water of H_2O	
4	Yonela: reading	For example one molecule	
5	Thandile	One molecule of H_2O has two hydrogens jonga eyamanzi uH_2O eyi-hydrogen ngu and hydrogen	Look water is H2O and hydrogen is and hydrogen
6	Yonela	Ayikho nye eyamanzi So one molecule of water	The water one is not one
7	Thandile	Yeka phandle	Leave it out
8	Yonela	Jonga Thandile uba uyibhale njani one molecule of water is like	Look how you've written it Thandile
9	Thandile	Iyaman' a-a	It's water no
10	Yonela	One molecule ya-manzi	One molecule of water
11	Thandile	Ha-a it's H2O and water is like the same thing mos	No it's H2O and water is like the same thing you know
12	Learner	Hm	
13	Robyn	Yes H2O is water	
14	Thandile	Nantso ke it's the same thing	There it is it's the same thing
15	Robyn	Well it's not it's not the same thing because water is the common name H2O is the scientific name	
16	Yonela	Hm	
17	Robyn	You're talking about the same thing but it's different it's not exactly the same	
18	Thandile	But then (inaudible)	
19	Robyn	But it's not the same thing	
20	Thandile	But you can't say water of H2O	
21	Yonela laughs	Yho, nyhani	Oh, truly
22	Robyn	We're the experts here	
23	Thandile	One example of molecule of H2O	
24	Yonela	Like Thandile sine-water u'ba like one molecule yalamanzi	Like Thandile we have water if like one molecule of this water

Thandile and Yonela's argument highlights a weakness in the reference book definition. The example which is meant to explicate that molecules can consist of different or the same atoms does not go far enough in providing clarity for a Grade 9 learner such as Thandile. He feels

that the expression 'one molecule of water is H_2O' is tautological and one should point out more clearly that a water molecule is an example of a molecule made up of different kinds of atoms, ie. a compound, because it is formed from oxygen and hydrogen. This he does in his own translated definition. Yonela offers a distinction between 'water' as a substance containing many molecules and 'one molecule yalamanzi' (Turn 24) indicating that indeed there can be a distinction between water and H_20. In Turn 15 I argue for a distinction on the grounds of there being a register difference between the everyday notion of water and 'the scientific name' (or more accurately, the chemical symbol).

Through argument Thandile and Yonela are employing thematic development strategies of equivalence and contrast (Lemke, 1990) in order to refine and deepen their understanding of the thematic item 'molecule'. Fundamentally, both learners create conceptually accurate definitions which truly express their present understanding of the topic:

Extract 7.15: SG8. Yonela's written expression of the underlined phrase in Extract 7.13

for example one molecule of water is H2O

Extract 7.16: SG8. Thandile's written expression of the underlined phrase in Extract 7.13

for example one molecule of H2O/water has 2 Hydrogens

Both could be challenged to improve these definitions or render them differently through further activities. What is evident from the debate is that the pair hold to their own translations: this is evidence, as I argued in Chapter 6, of discourse appropriation. They choose the translation that makes the most sense to them, while not erring conceptually.

Multimodality

During the discourse which accompanies this seatwork, learners employ alternative modes and text types to support their working-on-understanding of the definitions. Below we see Yonela supporting her argument for the translation of 'ukuzimela' into 'that can split' through the use of gesture.

Extract 7.17: SG8. Molecule split

Turn	Actor/Action	Speech	Gloss
1	Thandile	Molecule that can stand for itself	
2	Yonela Makes fists and moves hands away from each other rapidly	Ha-a that can like split kanje	No that can split like this

The debate continues after Extract 7.17 above and at one point Yonela articulates the need to define more than just the main concept and draws upon a different academic text type as a suggestion: a glossary. Here she demonstrates an appreciation of the complexity of scientific concepts and the need to be precise about meaning to avoid confusion, as well as an understanding of the semantic relations between terms and that meaning-making in science relies on making links between terms.

Extract 7.18: SG8. A glossary

Turn	Actor/Action	Speech	Gloss
1	Yonela: Taps the page with her pen	Thandile how about 'ba le nto like ba for each word siyenze apha le nto ba sibhale i-meaning yalo	Thandile how about that this thing like that for each word we do here this thing that we write its meaning

While Yonela doesn't use the word 'glossary', she uses gesture to indicate that she intends that they create a list of terms.

Other learners weigh in on Yonela and Thandile's debate. Mbulelo makes an appeal to broaden the semiotic repertoire for meaning-making to include drawing in order to aid understanding:

Extract 7.19: SG8. Mbulelo calls for trans-semiotising

Actor/Action	Speech	Gloss
Mbulelo	U'ba iyanixaka 'fethu	If it's too complicated for you my man

	ndithi ningazobi la nto	I say you can just draw that thing

His appeal to trans-semiotizing ('nitheni ningazobi la nto') is couched in a one-upmanship jibe ('U'ba iyanixaka 'fethu'). During the utterance, Mbulelo sits still with his hands in his lap and looks at his friend Mthobeli across the table. His posture here indicates confidence and a detachment from the struggles of the task with which the others are involved. This is typical of the identity work which he performs. In a single utterance he presents himself as a peer who is jostling for status in the group and an authoritative problem-solving student. Through gesture and body positioning he has created role distance (Goffman, 1975) between himself and the role of the academic.

Learners making meaning on the side

I move now from the meaning-making which forms part of the dominant communication channel in the classroom to that which is part of the subordinate channel (Goffman, 1981). In a learning space where an adult is tasked with leading the discourse, the meaning-making which this person ratifies comprises the dominant channel, while the non-ratified meaning-making comprises the subordinate channel. In a classroom, Goffman's (1981) term for communication between a sub-set of ratified participants, 'byplay', is similar to Lemke's (1990) term 'side-talk'. These are moments of meaning-making which happen 'off-stage', usually out of ear-shot or sight of the adult.

In this section, I will extend the notion of side-talk to include meaning-making in modes other than the oral. Learners may scribble notes in their exercise books or read ahead in the textbook or doodle a picture on a scrap of paper. In this section I will consider the examples in my data of when learners participate in this kind of meaning-making as they attend to the academic topic at hand.

Side-talk and gesture

Lemke calls side-talk in a classroom an 'active violation' (Lemke, 1990, p. 72). Lemke argues that side-talk plays three functions: as a channel for repartee between students; as a channel

for students to talk with someone other than the teacher about the lesson topic; and to provide an option for disengagement and to talk about something else altogether. Lemke sees all three as being essential to adequate functioning of the classroom. While the third function was well-represented in my data, it is the first and second functions which relate to Science meaning-making and which I deal with here. The examples which I present below concur with findings by Antia (2017) from a Western Cape university lecture setting, that 'hushed multilingualism' (2017, p.183) in the form of side-talk usually involved translanguaging.

Extract 7.20: C3. Lifeworld side-talk

Turn	**Actor/Action**	**Speech**	**Gloss**
1	Ms B	The metal is sodium so you're supposed to change uhm chlorine the ending will be IDE that's how you get chloride so you've got sodium chloride	
2	LG In a whisper to her seatmate	Ikwi-Colgate	It's in Colgate

In this first example, the learner has picked up on the teacher's word 'chloride' which sounds similar to 'flouride'. The learner has made an easy mistake confusing sodium chloride with sodium fluoride which is in fact an ingredient of toothpaste, or the brand Colgate, specifically. This comment brings her lifeworld knowledge to bear on the topic. Side-talk of this nature serves the speaker to position herself as a knower to her friend in relation to the topic of the lesson and expresses her specific interest in the topic which is to link these rather foreign-sounding names to something concrete in her world. Linkages such as this one were not made by the teacher in the dominant communication channel and so the side-talk sustains this learner's interest in the topic while the teacher adheres resolutely to the abstract activity of naming compounds. The same function of side-talk is apparent in the next example involving Thandile.

Ms B is aware of side-talk continuing between Thandile and his neighbour during a class discussion of metals and their states at different temperatures. As an admonishment for breaking the rule against side talk or 'talking' (Lemke, 1990), she asks him to account for the content of his talk. Thandile shapes a response which expresses some of the meaning he has

already been making in his side-talk. Mbulelo and Mthobeli, seated on the other side of the classroom from Thandile then begin to talk on the side about Thandile's response.

Extract 7.21: C2. Inserting lifeworld knowledge into classroom discourse

Turn	Actor/Action	Speech	Gloss
1	Thandile: Gaze to neighbour softly	Like uTerminator	Like The Terminator
2	Ms B Gaze to Thandile	Ja it has properties of a metal that's why it reacts like a metal even though it's a it has that exception of being a liquid <FAST>Ok. Thandile. </FAST> what you talking about cos you not talking about Mercury	
3	Thandile	(indistinct) Mercury	
4	Ms B	Ok please tell all of us cos we'd like to know	
5	Thandile: aloud	Ndithi Misi like ndibona iTerminator mna imetal (indistinct) ajika ayiliquid but same time i-metal (indistinct) ajikayo	I am saying Miss I watched Terminator, it's a metal (indistinct) which changes into a liquid but at the same time is a metal (indistinct) it changes
6	Mbulelo, to Mthobeli	Yhe?	Hey?
7	Mthobeli, to Mbulelo	e-e le makhi leya le ikhala kanje La nxi nxi nxi	Yes the my friend the one that sounds like this That nxi nxi nxi
8	Mthobeli, to Mbulelo	Le ijik' ithi	There one that turns and does this
9	Ms B gaze to Thandile	Ok we believe you let's move on to non-metals	

Thandile must first assert the relevance of his side-talk to the plenary discussion before he can win the right to speak in the plenary. His contribution, made in his most familiar register, seeks to show how a fictional character made of metal which is at different times liquid or solid has relevance to the discussion of Mercury, a metal that is a liquid at room temperature. His example comes from the popular action film series 'Terminator' which features a robot

which is made of a liquid metal alloy. On the other side of the classroom in this moment, Mthobeli is able to display his knowledge of popular culture to Mbulelo by mimicking the sound and movement of the robot. Both Thandile and Mthobeli are in this moment of side-talk performing their scientific and social identities simultaneously (Ballenger, 2010) through engaging in repartee and the Science topic at hand (Lemke, 1990). While they are both students of Science in a classroom, they also position themselves as teenage boys who watch science-fiction movies.

Thandile's contribution also reveals a misconception which he shares with at least Khethiwe (as evidenced in SG 5) but probably more learners. He fails to distinguish between elements which are metals and their state as a gas, liquid or solid. Unfortunately, this contribution, centering on a learner's interest but also his misconception, is not taken up by the teacher. Rather, she takes control of the pacing of the lesson by indicating that we are all going to 'move on' (Turn 9) to the next topic. Lemke (1990) suggests that this is a strategy for teachers to keep to their own agenda or interests:

> Teacher control of pacing can be used strategically to create a sense of the "pressure of time" which can make it easier for a teacher to forestall student initiatives and keep to his or her own agenda for the lesson. (1990, p. 65)

Contributions such as Thandile's serve his interests as a learner. Lemke (1990) pits learner interest against teacher interest in one general aspect: learners want to master the topic and 'hav(e) the least material taught for which they will be held responsible on a test' (p.65); whereas the teacher acquiesces to curriculum demands that 'a certain amount of material be 'covered: regardless of how well it is learned' (ibid.).

The last extract of side-talk is taken from the study group. In the fourth study group session, I screened a Youtube clip[51] produced by the Canadian Museum of Nature (2011). It is an animation of oxygen and hydrogen atoms reacting to form a water molecule. The atoms forming bonds with each other is depicted using a straight line between ball-shaped atoms. While viewing this, Nomvuyo says aloud to an indeterminate audience, 'looks like they fighting' (SG4). In this example, the difference between side-talk and back-channeling

[51] https://www.youtube.com/watch?v=sBZfPmIcS-E

becomes negligible. Nomvuyo draws an analogy through the personification of atoms giving them the character of stick or sword fighters. I later add to this analogy by remarking 'a light sabre' which is what I associate with the little lines between the balls in the video, valorising her contribution. Nomvuyo provides the third example of the spontaneous connection of academic and social worlds through side-talk.

The thematic development strategy (Lemke, 1990) employed by all three learners in their side-talk is called rhetorical connection. They make analogies or draw examples from their lifeworld to make meaning of the Science topic: sodium chloride is connected with toothpaste; Mercury with The Terminator; and atoms with fighters. In this way they are able to simultaneously perform the identities of teenager and Science student.

Spontaneous note-making

Although not exhorted to do so, some learners made notes during teacher exposition or go-over activities. Figure 7.2 is a photograph of Khethiwe's notebook including some of her spontaneous notes taken during Class 3.

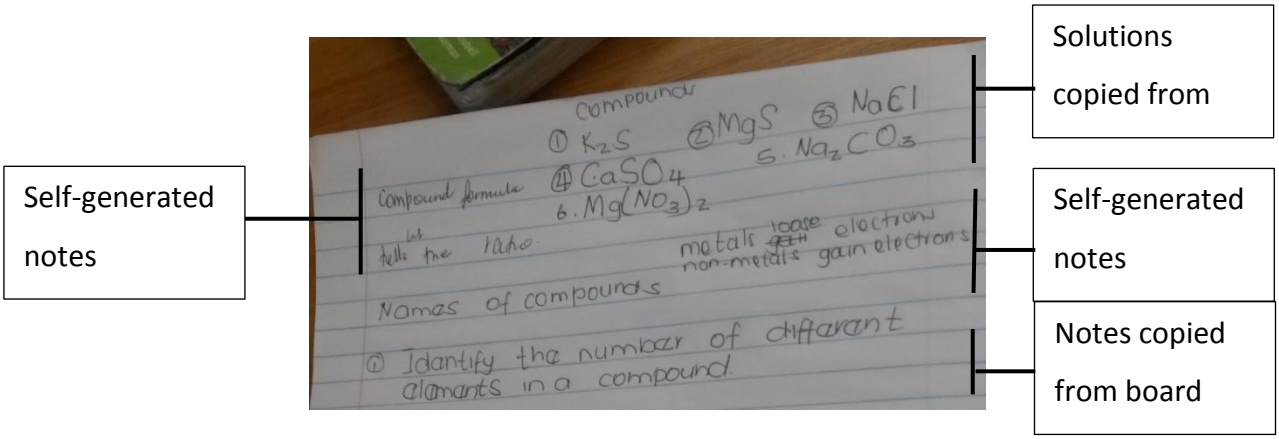


Figure 7.2: C3. Khethiwe's exercise book

This page from Khethiwe's exercise book depicts two kinds of writing. The first is notes which she has copied verbatim from the board as the teacher wrote them up. This activity was referred to by Ms B as optional as she explained that the notes appeared in the textbook as well. The second kind of writing was not referred to by the teacher, but was produced spontaneously by Khethiwe. This demanded active listening on her part as she followed the

teacher's talk and determined what was important enough to write a note about, hence revealing her interest.

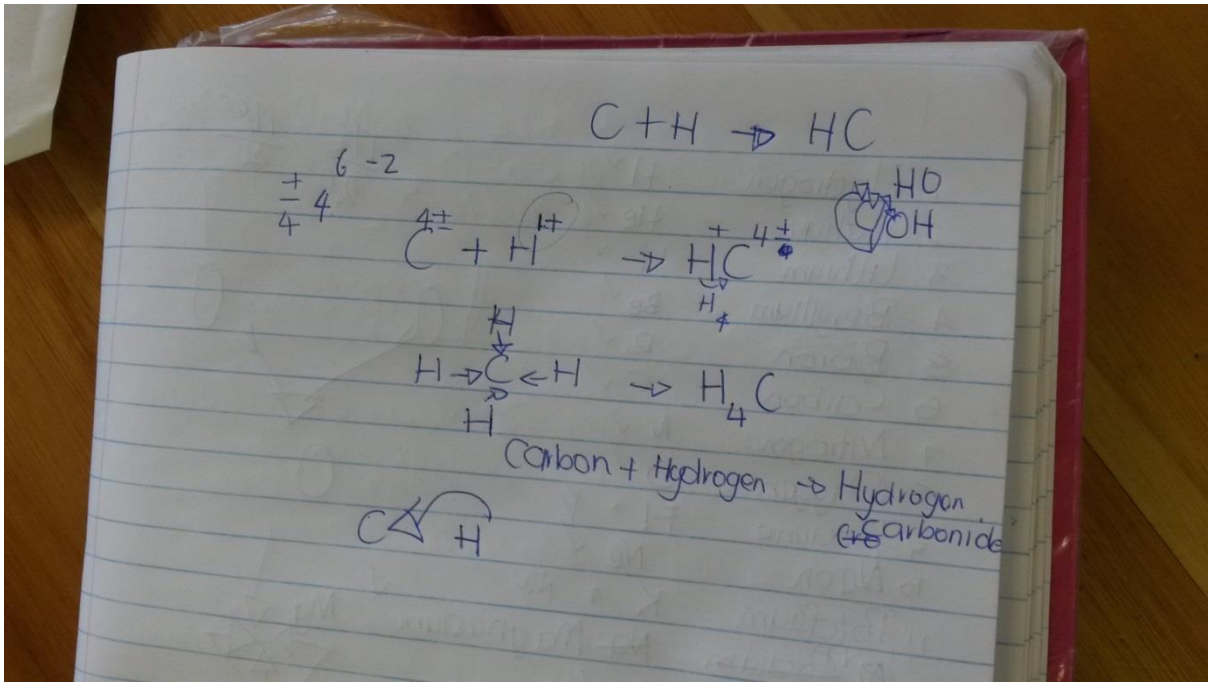


Figure 7.3: SG8. side drawing while working on understanding

Figure 7.3 is a copy of the text that Khethiwe produced during just over four minutes of individual seatwork during SG8 on the problem: 'What is the chemical equation for this word equation: carbon + hydrogen → hydrogen carbide?' It is typical of what populates students' notebooks the world over, and indeed much of what scientists scribble about on the 'back of envelopes' (Lemke, 2004, p.33). It is exploratory rather than presentational (indeed, she does not reach a solution) and therefore cannot be said to follow conventions of text-image presentation or a grammar of visual design (Kress & van Leeuwen, 2006) very strongly. Space has been used on the page for convenience rather than in an ordered way. On the video recording, Khethiwe is shown skipping from one part of the page to another without linear progression over time. Its purpose rather is to contribute to Khethiwe's meaning-making as she tries out different expressions of the problem. Some parts of her text-image are representational - such as the arrows of different shapes representing processes, the chemical symbols and the chemical names - and should be considered as part of the text which she can review. Others are mere traces of her meaning-making in the actional mode,

such as circling 1+ (top-middle of Figure 7.3), and serve as to help her focus on that part of the problem in the moment and are not reviewed.

Khethiwe's two notes were produced during an activity which was set up by a teacher or facilitator. As an indication of the range of what learners draw upon from their semiotic repertoires when making meaning on a topic of their choosing, I present a text-image copied from the inside cover of a reader for the school subject isiXhosa Ulwimi Lwasekhaya Ibanga 9 (isiXhosa Home Language Grade 9). Although the author is unknown, it is assumed by virtue of its position inside the textbook cover and not in a class exercise book, that it was created spontaneously, perhaps even outside of class time.

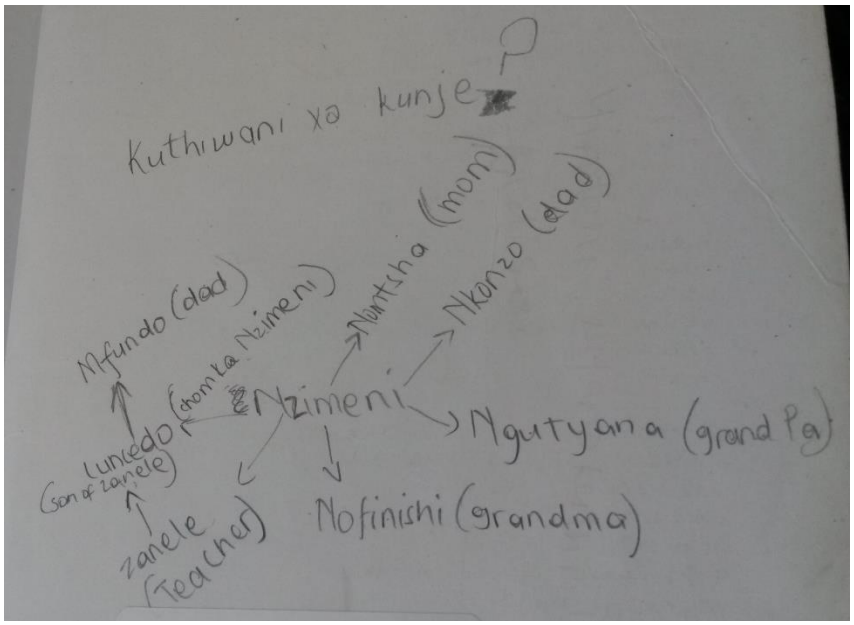


Figure 7.4: Spontaneous anonymous mind map 090216

This text-image is a mind map or concept map of the characters in a short story. The learner has used the names of the characters and in brackets, a short description of each as an aide memoire. Through the use of arrows s/he has indicated their relationship to each other. The short descriptions employ translanguaging through drawing on different features from his/her repertoire. 'Chomka' (friend of) reflects isiXhosa and township youth features, while 'son of' and 'grandma' and 'teacher' are English features which can occur in township youth registers as well. The inclusion of the English features is particularly interesting given that the isiXhosa Lwasekhaya subject, like other language subjects at this and most Western Cape schools, ascribes to a monoglossic ideology and so this kind of languaging would be frowned

upon in the classroom. This is evidence of the register-meshing which occurs naturally when learners are completely unfettered by language policy and have as their goal simply conceptual understanding.

Spontaneous reading

A form of meaning-making which occurred spontaneously in both the study group and the class lessons was the spontaneous reading of topic-related texts in the classroom, usually during teacher-led triadic discourse. This spontaneous engagement with the content of the topic is seldom noticed let alone applauded by teachers.

During a go-along (Kusenbach, 2003) discussion after a 9B lesson with Ms B she confided that 'I'm struggling with them' and 'I don't have control of this class whatsoever' (C7) and 'I'm moving forward alone'. I commented how much reading of the textbook they were doing, which, for me, indicated engagement:

Extract 7.22: C7. Teacher go-along

> Robyn: Do you know what? As I was looking around, every single one of them had a textbook open, they were going backwards and forwards to try and work it out.

Independent reading was not encouraged by Ms B, therefore the learners' spontaneous reading of the textbook provided clear evidence for me of their engagement in the topic.

To prepare for the first few study group meetings, I laid out topic-related Science reference books which I picked up from the library shelves. I hoped that these would tantalise the learners into browsing through them during liminal periods and thereby take up the opportunity of 'incidental reading' which is important for literacy development (Makalela, 2015, p.20). There is one piece of video data evidence of three learners browsing through these books, engaging in spontaneous reading, during the first study group.

Conclusion

In this chapter I have outlined the category of spontaneous meaning-making drawing on examples from the class lessons and the study group. The characteristics of spontaneous meaning-making which the examples reveal are:

- it foregrounds the learners' interest (Kress et al., 2014) and sense-making purposes (Rosebery et al., 1992) as they explore new meanings
- it often occurs in spaces of collaboration between learners
- it can occur in resistance to constrained meaning-making
- it often consists of natural translanguaging (García & Li Wei, 2014), trans-semiotizing (Lin, 2015) and meshed registers (Gibbons, 2006) in which learners draw freely upon any features of their semiotic repertoires (Kusters et al., 2017) which fit the purpose at hand.

The kind of Science meaning which is made in this category is meshed with the social identities of learners in a way which makes possible the appropriation (Bakhtin, 1981; Rosebery et al., 1992; Brown, 2006) of the new discourse of Science. The learners reach out from a familiar identity position into one which is unfamiliar; a process which can be a struggle and involve deft identity work. Mbulelo is a learner who exhibited this work on many occasions. For many of these emergent bilingual learners the complexity of simultaneous identity performance (Ballenger, 2010) and expressing scientific themes just would not be achievable if they were limited to using English only. While canonical school Science meanings are sometimes not made accurately in the exploratory discourse (Barnes, 1992), this presents an opportunity for further conceptual work through guided meaning-making with a teacher or facilitator.

The next chapter comprises the conclusion of the study, including recommendations of a practical and theoretical nature.

8 Conclusion

> *We face significant challenges of unjust standardized assessments, restrictive education policies and general resistance to a heteroglossic understanding of language as social practice. But the good news is that we know it is possible to implement transformative approaches to language and literacy inside and outside of formal schooling because…this is already being done!*
>
> - McKinney, 2017, p.170

Introduction

In Chapter 1 I outlined the goals of this study for the development of theory and practice. This final chapter is an account of the work I have done to achieve these goals. In revisiting the theoretical goals, I will summarise key insights gained from the data analysis towards extending applied linguistic theories of meaning-making, as well as outlining the limitations of the study in this regard. On a practical level, I will offer recommendations for teaching and learning methodology in post-colonial content classrooms such as those in South Africa.

Key contributions of the study

I begin with a summary of the key contributions of the study which address my research questions, restated here:

How is Science meaning made through the multimodal discursive practices of a group of bilingual Grade 9 Natural Science learners during one topic of study?

1. What semiotic practices were observed in the classroom and study group?

2. How are these practices shaped by the language environment of the school and beyond?

3. What kinds of meanings (and their trajectories) are made as a result of these practices?

4. What are the implications of studying bilingual meaning-making with a semiotic repertoire lens?

Three broad categories of meaning-making

In answering my first question, I sought a comprehensive theory of the Science meaning-making that the bilingual learners were engaged in. The aim was to incorporate all modes, registers, identity positions and channels of communication that were identified in the two sites into one theory. Taking semiotic repertoires (Kusters et al., 2017) as my departure point in analysis enabled me to describe modes rather than just verbal language; and registers, rather than just named languages. Therefore, I gained a more comprehensive view of these bilingual learners' meaning-making practices.

Following the approach of linguistic ethnography, I allowed categories of analysis to emerge through working with the data. In building these categories I have taken an interdisciplinary approach. From applied linguistic scholarship, I have drawn upon the concepts of 'translanguaging' (Li Wei, 2017; García & Li Wei, 2014; Creese & Blackledge, 2010), 'trans-semiotising' (Lin, 2015) and exploratory and presentational talk (Barnes, 1992). I have also applied concepts derived from monolingual Science learning studies such as 'activity types', 'semantic relations', 'thematic development strategies' (Lemke, 1990), 'meaning-making' (Mortimer & Scott, 2003) and 'multimodality' (Kress et al., 2014). These terms drawn from different disciplines allowed me to account for bilingual, or translingual, practice not as exceptional, but as normal. Such translingual practice has been described as part of a broader conceptualisation of learner meaning-making as multimodal and multilingual as it occurred within the constraints of this particular post-colonial schooling system. From the application and development of these concepts in my data analysis, the three categories of meaning-making emerged (summarised in Table 8.1). While these categories emerged from bilingual data, I propose that they could be applied equally well in a 'monolingual' (but multi-register) context.

Table 8.1: Three categories of meaning-making

Meaning-making category	Discourse structure and typical activity types	Semiotic resources drawn upon	Science meaning made
Type 1 constrained	• teacher-controlled • fixed words valued • presentational discourse demanded • found in whole-class activities such as teacher exposition, review, seatwork and testing • learner texts are short • subordinate channel used by learners, but not accessed by teacher	• demand for 'standard' registers of English from learners • linguistic mode valued and recognised • meaning-making framed as monomodal	• one view on the topic is expressed • aligned with school Science canon • follows the interest of the teacher, curriculum and standardised assessment requirements • lacks expression of conceptual depth by learners • meaning as settled and authoritative
Type 2 guided	• teacher- and learner-guided • flexible wordings • extended seatwork activities employing trans-semiotising/ translation • found in true dialogue and teacher questioning activities	• particular registers, modes and genres focused on at times • all registers and modes valued and recognised including meshed registers	• aligned with school Science canon • extended beyond school Science following learner interest • meaning-making as emergent and co-constructed
Type 3 spontaneous	• learner- initiated • flexible wordings • exploratory • occurs in dominant and subordinate channels and crosses these	• any feature is recruited according to learner's interest • meshed registers and translanguaging prevalent	• aligned with learners' interest (inquiry-based) • school Science canon and beyond, in negotiation with lifeworld experience • meaning-making as emergent and co-constructed

Constrained meaning-making was used for exposing learners to the authoritative scientific view (Mortimer & Scott, 2003) in a topic through exposition or review as well as going over seatwork and constrained seatwork/testing (Lemke, 1990). Its predominance in the class lessons militated against learners appropriating the science discourse for their own interests (Rosebery et al., 1992) and being able to use it flexibly for making meaning (Lemke, 1990). Learners were expected to produce texts in a narrowly-defined presentational register (Barnes, 1992) without the demand for displaying deep conceptual understanding. The restrictive language policies in the school and Ms B's class; the use of one textbook as LTSM and the looming presence of standardised tests in English only; encouraged the dominance of constrained meaning-making. In this type of meaning-making learners were assisted by the teacher's or facilitator's thematic development strategies (Lemke, 1990), such as glossing, tone concord and apposition. However, the impact of these strategies was limited by the lack of opportunity to read, write or discuss (using metalanguage) the scientific register in English that was required by the test. Nominalisations (Halliday & Martin, 1993), particularly, posed a challenge to most learners in understanding and responding to questions which contained them. Tracing a *meaning trajectory* through the classroom discourse of the lessons prior to the test revealed that learners were not expected to produce the kind of flexible wordings in the scientific English register in class which the test demanded – amounting to an 'incomplete journey' (Setati et al., 2002) or trajectory. This occurred as a result of the predominance of constrained meaning-making in class.

Guided meaning-making occurred when learners made meaning as a result of the teacher or facilitator's guidance combined with pursuing their own interest, either in choosing a topic or in the semiotic resources they used to express their meaning. A notable feature of this kind of meaning-making was the extended texts – in any mode – produced by the learners. The registers (Martin, 2010) which the learners employed to make meaning varied. At times the guidance of myself as facilitator of the study group required that learners employ a specific register in order to exploit its particular meaning-making potential. The activity, such as translation or diagram interpretation in verbal language, therefore fulfilled the definition of 'official translanguaging' (García & Li Wei, 2014, p.91) and resulted in developing learners' 'expanded repertoire' (Lin, 2015) for Science. The distinction between 'official' and 'natural' translanguaging in learning has been salient in my study and I have extended these terms to

create a distinction between 'official' and 'natural' trans-semiotising (Lin, 2015). I argue that the learning purposes that each type affords are so diverse that researchers should always refer to the sub-type when describing translanguaging in education contexts. On other occasions, the choice of register was left open to the learners to complete a task employing whichever features of their semiotic repertoires they saw fit. In this way the discussion and critique of registers for learning Science was enabled.

The alternative and transgressive meaning-making activities which we explored in the study group provided the context for a contribution to challenging ideologies of the Science register as fixed and bounded in South African schooling. The learners' meaning-making practices have also provided evidence of the consequences for learning when these ideologies are challenged. Learners drew on different features from their semiotic repertoires to create a meshed register (Gibbons, 2006). The guided meaning-making activities which supported the use of learners' full semiotic repertoires produced multimodal learner texts which can be described as comprising 'flexible wordings' (Lemke, 1990) which expressed the essential meanings of Science. Part of this meaning-making process – and in line with inquiry-based learning (Montuori, 2008) - involved uncovering misconceptions and puzzlements (Alvermann, 2004) learners had about these essential meanings which remained obscured in the monolingual, tight IRE discourse of the classroom. The use of metalanguage in guided meaning-making activities which required learners to translate between modes or languages resulted in language or register awareness which enabled deeper conceptual understanding.

The last category, *spontaneous meaning-making*, has been described with only a small selection of the total instances from the data. These have necessarily been instances which explicate the kinds of meanings made possible by this type which were not possible in the other types. These are data from the 'underlife' (Gutierrez et al., 1995) or 'subordinate communication channel' (Goffman, 1981) of the bilingual classroom and study group. Side-talk and gesture as well as seat-talk was often found to be about the Chemistry topic under study. The analysis of this 'hidden' meaning-making has provided evidence – in accordance with Msimanga and Lelliott (2014) and Antia (2017) - of learners expressing misconceptions; wrestling with concepts towards understanding; and connecting the science with their lifeworld knowledge. In spontaneous meaning-making learners often meshed their social and academic identities (Ballenger, 2010) to move learning forward. The capturing of

spontaneous meaning-making through writing up learners' questions publicly in the study group provided a useful resource for working on understanding throughout the study of the topic as well as for valorising learners' contributions to the topic. In addition, spontaneous meaning-making provided a respite from studying through the medium of English only.

An important feature of both spontaneous and guided meaning-making was found to be the activation of different identity positions which supported learners' academic learning, leading to Bakhtinian (1981) discourse appropriation. Learning school Science successfully as a bilingual learner in an African language dominant community today requires deft identity work in a similar way to minoritised communities elsewhere (Ballenger, 2010; Brown, 2006). School Science consists for these learners precisely of words which 'remain alien, sound foreign in the mouth of the one who appropriated them' (Bakhtin, 1981, p.293). It is a battle to make them part of the learner's repertoire. Acquisition of the register required for school Science is possible if fixed words (Lemke, 1990) are all that is needed. However, this is seldom the case even in the constrained context of a standardised test. If 'the private property of the speaker's intentions' (Bakhtin, 1981, p. 293) is going to be brought to bear at all in the learning process, resulting in flexible wordings which adapt to different situations, then learners need to play with new identities through meshing them with established ones. Khethiwe and Mbulelo provided good examples of this process. Khethiwe was able to use multimodal expression to express one identity position in one mode and another in another mode, thereby constructing a fluid identity matrix (Makalela, 2014). Mbulelo was able to create meaning which allowed him to simultaneously express his academic and social identity positions. Meshed registers were often the vehicle employed to expressed meshed identities.

The three categories were intentionally designed to be broad and not to foreground named languages in their nomenclature. I argue that this positions the bilingual practices of the learners as integral to the learning process and not as optional, but attractive, extras. At the same time, it allows for bilingual, or translingual, practice which does not necessarily move learning forward, but constrains it. As Jaspers (2017) has argued, there is nothing inherently transformative about translingual practice, or translanguaging, rather its social – and in this case, learning - function must be examined in use.

The contributions of my study offered by the analysis of the interactional data produced by participants during the topic of study are:

- the three categories of meaning-making which emerged as an over-arching theory of meaning-making in this context, and which I argue can be used in learning contexts beyond this;
- the specific importance of identity work for successful science learning amongst minoritized learners, and the role of various registers and modes in this;
- that science learning discourse is meshed rather than constituting a binary of everyday/scientific registers.

The influence of the language environment

My second research question sought a connection between the language environment of the school and the semiotic practices of the classroom and study group. The ethnographic methods which I employed in the study were crucial to an understanding of this connection. The various kinds of data collected during my fieldwork pointed to a strongly Anglonormative (McKinney, 2017) ideology in operation. The language policy; contents of the library; interviews with the Principal and Natural Science teacher; and text displayed around the school all constructed and reinforced this ideology. Long-term patterns of practice in classrooms in the school also reproduced and reinforced Anglonormativity. Interventions such as my study group, therefore, face a challenge when taking a different perspective on language use for learning. Offering new ways of making meaning in Natural Science which incorporate their most familiar registers can feel like anathema to learners who are steeped in eight years of schooling in which the only meaning-making which counts (Hicks, 2003) has been in English. The learners who performed translation tasks in the study group resisted using isiXhosa resources, including 'esenginqi' (local language), to produce Science definitions. This was despite learners drawing on a wide range of resources from their semiotic repertoire when making meaning spontaneously in the oral mode. The shift into a written mode and scientific register which some of the study group activities demanded lent an accountability and permanence to learners' Science meaning-making in isiXhosa which was usually reserved, in tests and classwork, for English. Therefore, the activities I designed for

the study group such as the translation exercise and exploratory writing in isiXhosa were small forays into uncharted territory in which meaning-making resources had to be reimagined.

The contribution of my study offered by the analysis of the language environment of the school is to the body of empirical evidence for Anglonormativity as a strong force in the schooling of the minoritized majority, even in interventions which seek to broaden what counts as semiotic resources for learning.

Limitations of the study

The methodology of a case study with an intervention component was argued for in Chapter 3. This allows in-depth analysis of meaning-making practices and experimenting with new practices in order to challenge normative ideas about bilingual Science learning. This kind of research is not designed to enable generalisability to a population.

Much of the analysis presented in Chapters 6 and 7 is performed on a small sub-set of the main data set. This is because the study group met only eight times and was conceived of late in the research design and so its intervention was limited.

Taking on a multimodal approach to meaning-making meant that data sources were vast and the potential for levels of analysis large. As a lone researcher the burden of analysis was great and I certainly would have benefitted from being part of a team of researchers working on the same data. This however, is not standard practice in doctoral research in the Humanities in South Africa. The solitary nature of analysis was somewhat ameliorated by the excellent support I received from peers and my supervisor, but nevertheless working in teams is recommended in linguistic ethnography (cf. Copland & Creese, 2015) and therefore my study was limited by my working alone. Equally, as argued in Chapter 3, my limited isiXhosa proficiency, while helpful in positioning me as a learner, also meant I did not comprehend all of the meaning-making that happened in-situ. Therefore, as facilitator of the study group, I could not always respond to learners' meaning-making in isiXhosa and guide this further.

Recommendations for teaching and learning practice

The scholarly contributions of the thesis outlined above align with the vision of bi/multilingual education espoused by García and Li Wei (2014) termed 'dynamic bilingualism' (13) – an acknowledgement at all levels of educational planning and implementation that 'the language practices of bilinguals are complex and interrelated' (14). This vision informs all the recommendations that follow.

Teacher education

The meaning-making lens which I applied to bilingual Science learning has implications for teacher education in general education courses, as well as in specific subject teaching courses. My research shows that teachers need a combination of understanding bilingual learners' semiotic repertoires as resources for learning and understanding learning as discourse appropriation. Science teaching methodologies that draw on learners' home language registers may be equally constraining as English-only methodologies if the link to learners' interest is not made through inquiry-based approaches which facilitate flexible expression of semantic relations, such as those analysed as guided meaning-making in my study. The analysis of the identity work and conceptual explorations involved in spontaneous meaning-making in my study has underscored the importance of teachers providing opportunities for the kinds of spontaneous meaning-making learners engage in (such as side-talk and seat-talk) and harnessing this towards discourse appropriation.

The analysis of one semantic relation forming part of the topic of 'Chemical Reactions' in the classroom discourse and the test provides impetus for educating content teachers about semantic relations and the different expressions these can take along a meaning trajectory. Some understanding of the linguistic peculiarities of scientific language (eg. nominalisations) will also assist Science teachers in preparing learners to be able to use this register in tests and other scientific communications, as argued by Gebhard et al. (2014).

The dominant language ideologies in the school and the ways in which these shaped and constrained classroom practice have important implications for teacher education. Powerful language ideologies need to be tackled in teacher education alongside the teaching of skills for multilingual classrooms as these will not take hold if language ideologies which make teachers resistant to the use of learners' full semiotic repertoire in learning are not addressed.

These ideologies are held by teachers, parents and learners. Drawing attention to the use of different registers in exploratory discourses would be a prudent place to start, especially if teachers are resistant to presentational discourse in anything other than English.

Materials development

The analysis I performed on one semantic relation in the test showed that South African teachers will be assisted by the development of curriculum documents which map out trajectories for the appropriation of the discourse of an academic subject. These are not intended as glossaries, but maps for dealing with increasing complexity in expressions of a semantic relation through its development from the Foundation Phase (Grades R-3) to the Further Education and Training Phase (Grades 10-12). Alongside the explication of content to be taught, curriculum documents should include guides on teaching using metalanguage to support the learning of academic discourse.

My intervention through a translation activity in the study group showed that resources which include multilingual activities and multilingual text will aid learner comprehension and validate the linguistic resources which they have. Resource packs for teachers of content subjects guiding them through translanguaging activities and activities where learners can generate their own questions about a topic are, in the short-term, less costly than textbooks and I recommend starting with these.

Policy development

Language in education policies, whether at a national, provincial or school level, need to be leveraged more strategically if they are to be forces to support quality teaching and learning as well as institutional transformation. Language policies in schools can address the domains of language in learning, language as subject and language for community life. My analysis of the Success High policy revealed a monomodal and monolingual view of meaning-making in the language in learning aspect of the policy. Extending the language policy to account for learners' meaning-making in modes apart from the spoken and written would do much to legitimate these modes for learning as well as to make educators aware that these are

pedagogic tools. I also recommend the acknowledgement in policy of the bilingual reality of most schools, and learners in particular, and an acknowledgement of the key role that different registers play in learning.

Language in the broader community life of the school is an important aspect of any language policy not only because it incorporates members' self-esteem related to whether they feel their languages are valued at school, but also because the use of language outside the classroom affects learning as has been shown in my case.

All language policies pertaining to education should be more rigorous and detailed at the national and school level. Working with and understanding language policy should be a key part of staff development.

Assessment practices

In making recommendations about the use of learners' full semiotic repertoires in teaching and learning, I face my biggest challenge in assessment practices. However, these need to be tackled as assessments have a powerful back-wash effect on classroom practices. As the example of the class test in my case showed, summative written assessments such as tests and examinations in multilingual settings have been highly restrictive in terms of condoned registers and the kinds of questions asked. While introducing multilingual summative assessments is a worthy goal, I believe it will need to be preceded by the implementation of multilingual formative assessments as a testing ground for this novel approach. This kind of assessment is more likely to be decentralised and locally relevant and can incorporate the registers familiar to the class of children being assessed. Assessment activities which require learners to reflect on their learning can draw upon an expanded repertoire and flexible wordings, showcasing what they know rather than what they don't know. Assessments should include meshed registers as well as more restricted scientific registers.

Recommendations for further research

Crossing bilingual and monolingual contexts

Translanguaging has proved a powerful concept in multilingual education research. Li Wei's recent bold call (2017) to free this concept from application only in bilingual contexts and to use it as a foundational concept in the theory of language in general, is attractive as it enables research to be conducted across monolingual and bilingual contexts using a common theoretical tool. In a country with a two-tier education system such as South Africa, with one tier catering to largely monolingual English, privileged children and one catering to the multilingual minoritised majority, research which cuts across these tiers is rare. By employing the three meaning-making categories that I have in this study, I have offered a framework for researching classroom discourse which can be applied in monolingual or multilingual contexts. Future work which seeks common processes at work in these divergent contexts would do much to reduce the exceptionalism of bilingual education and the deficit ideologies which constrain translanguaging approaches to teaching and learning.

Learner-centred research

To date, South African classroom discourse research has been focused on plenary, teacher-controlled settings. In a busy, noisy environment such as a classroom, it is easier and more efficient to capture data from plenary discussions than learner discourse in groups, but we need to know more about learner-to-learner meaning-making. I have made a case in this thesis for the importance of the meaning-making which takes place through discourse between learners, especially between teenagers for whom the peer group is highly significant. It is likely that for the foreseeable future research into the use of bilingual learners' semiotic repertoires for meaning-making will take place predominantly in intervention situations as the language policy environments in schools are not conducive to teachers employing learners' full repertoires as meaning-making resources in the classroom. Further, I recommend extending the study of Science meaning-making beyond school into the home and community as these contexts shape the kinds of meanings made in the curriculum topic.

Meaning trajectories

Research on learners' meaning-making in a topic should incorporate a time dimension, as argued by Mercer (2008). One way to do this would be to research meaning-making in one topic as it occurs through one phase (such as Senior Phase). This can inform curriculum documents for content subjects which assist educators to provide appropriate scaffolding for emergent bilinguals at different stages of their learning in a particular topic, across phases, grades, units and lessons.

Partnerships outside of schooling

Research partnerships across the full spectrum of Science learning as it takes place across the lifespan will enrich the study of Science meaning-making in schools. Researching the semiotic repertoires of multilingual career scientists as well as tertiary level students and lecturers working in South Africa would lend much validity to the arguments I make in this dissertation.

Conclusion

At the start of this thesis I drew attention to the current social movements calling for free, decolonised education in South Africa. The project of envisioning the character and substance of decolonised education, 24 years into our democracy, is pressing and intertwined with a vision of decoloniality in society more broadly. The present study has the potential to contribute to this national undertaking through the potentialities of *guided* and *spontaneous* meaning-making in particular. As Christie and McKinney suggest, given the exclusive privileging of English resources, 'shifts in the language policies and practices of schooling are an essential starting point for a programme of delinking (from coloniality)' (Christie & McKinney, 2017, p.18). As part of this delinking, let us embrace a vision of young people learning Science that is different from the status quo where the bilingual minoritised majority achieve at worst *parroting* and at best *acquisition* of Science discourse in the colonial language. We need a vision of *discourse appropriation* - where learners draw on their full semiotic repertoires to confidently make science their own and lend their voices to shaping scientific endeavour.

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Addendum 1: Transcription conventions

Symbol	Meaning
…	a pause, each dot indicating a second
(indistinct)	the speech was indistinct and so is not transcribed
/	speech has been omitted, next relevant clause continues after the /
L	learner
L1	specific learner
Ls	More than one learner speaking simultaneously
T	Teacher
I	interviewer
(1)	number given to a speaking turn in a long extract
//	Overlapping speech
superscript	Rising intonation
subscript	Falling intonation
Underlined	Syllable emphasised
<fast> </fast>	Faster than normal speech begins and ends
:	Follows a lengthened sound
bold	Significantly higher volume speech than surrounding speech
italics	Significantly lower volume speech than surrounding speech

Addendum 2: Learner language questionnaire

Learner Questionnaire

Thank you for filling in this questionnaire which forms part of my PhD study. Please note that it is optional and you may make it anonymous.

Robyn Tyler

Home class: _____ Sex: _____ Name (optional): _____

Language:

1. What is your home language/s?

2. How did you decide on your answer to 1? (eg. It is the language I use the most/ They are the languages spoken in my home.)

3. What other languages do you speak? (write them in order of how well you speak them)

4. What other languages, not yet written down, do you understand? (even a little bit)

5. Which language do you read best?

6. Which language do you write best?

7. Which language do you love the most? Why?

8. English is the Language of Learning and Teaching in this school. Please write about how you learnt English.

9. In Natural Science lessons, do you prefer working in (tick) English ☐ isiXhosa ☐ both English and isiXhosa ☐ Why?

Home:

10. Which area/s do you live in? (eg. Site C/ Ilitha Park/ Mandalay and Kuyasa)

11. Who else lives at home with you?

12. Which languages are spoken in your home?

Any other comments about your language use and school:

Thank you very much for filling in this questionnaire

Addendum 3: Staff language questionnaire

Staff Questionnaire

Thank you for filling in this questionnaire which forms part of my PhD study. Its purpose is to understand the language resources of the staff and the experiences of using languages at school. Please note that it is optional and you may make it anonymous.

Robyn Tyler

Sex: _____ Age: _____ Name (optional): _____ Teaching subjects/ Job title: _____

1. In which area do you live?

2. What is your home language/s?

3. How did you decide on your answer to 1? (eg. It is the language I use the most/ They are the languages spoken in my home.)

4. What other languages do you speak/use? (write them in order of how well you speak them)

5. What other languages, not yet written down, do you understand (even a little bit)?

6. Which language do you love the most? Why?

7. Teachers: Which language/s do you use in the classroom?

8. Which language/s do you use at break time, with whom?

9. Teachers: Do you have any rules about language use in your classroom? Please describe briefly.

10. Teachers: Do you experience any challenges relating to language in your classroom? Please describe briefly.

Thank you for filling in this questionnaire.

Addendum 4: Principal Interview schedule

Date and time of interview:

_____

General school:

1. What is the history of the school?
    a. Which partners were involved in starting the school in 1999?
    b. What is this school's relationship with (the university)?
2. Where do your learners come from?
    a. Area
    b. School
    c. How are they selected?
3. FET Subjects: English HL, Xhosa FAL, LO, Mathematics, Physical Science, Life Science, Computer Studies.

Being Principal at Success High:

4. What is your history at Success High?
    a. Started in 2003?
    b. Principal since 2008?
5. Where did you teach before?
6. Could you tell me about your education?
7. What is your role at Success High?
8. What is particularly delightful and/or challenging about working here?

Your languages:

9. Could you talk about the languages you speak and know?
    a. What, when, who, why?

The language at school:

10. Does the school have a formal language policy?
    a. Who drew it up?

b. How is it communicated?

c. How do you and the school feel about it?

11. Could you talk about how you use language differently with

a. Staff

b. Parents

c. Learners? (particular experiences in teaching Maths)

d. And in different kinds of communications (eg. email vs face-to-face)

12. Could you talk a bit about the language used in school for learning content subjects?

b. Learners' strengths and struggles with language in content subjects in your school as you have experienced them?

c. Any staff development about language for learning?

d. Any staff problems or concerns about language for learning in school?

Addendum 5: Teacher Interview 1 schedule

Natural Science teacher interview 1: Approx 60 minutes, before classroom discourse data collection

Date and time of interview:

_____

Name and age of interviewee: _____

Position at the school:

_____

(Who are you? Why do you do what you do? What do you believe about language use in school?)

Biographical info:

1. Who is in your family
2. Where did you grow up?
3. Where did you go to school and university? (probe working with university programme last year)
4. How did you become a Science teacher?
5. In which schools have you taught?

Your language:

6. Could you talk about the languages you speak?
    a. What do you speak?
    b. What do you know?
    c. When do you speak what with whom?

The language at school:

7. What is the school's language policy?
8. What are your attitudes/ beliefs towards Xhosa and English at school/ in your classroom?
9. What is your attitude towards the use of Xhosa and English at school?
10. Could you describe the languages spoken by the Science department?

11. What sorts of discussions do you have with colleagues around language in Science?
12. Could you talk a bit about how you interact with parents?

Teaching science: (look for anecdotes)

13. What do you believe makes for good Science teaching?
14. How do you plan?
15. Do you have any rules about language in the classroom?
16. What makes a good Science learner?
17. How did you learn science?
18. Can you talk a bit about the selected topic for this research?
    d. What has influenced your presentation of this topic of science?
    e. What is important for the learners to know in this topic?
    f. Do you like it?
19. What challenges do you face teaching Grade 9 Natural Science?
20. Which concepts do learners find most challenging in Natural Science?
21. How do you incorporate your learners home lives in the classroom?
22. What extra mural science activities are your learners involved in this term? (Science Centre Acids and Bases and Atoms)
23. What do you think of the prescribed textbook?

Addendum 6: Teacher Interview 2 schedule

Natural Science teacher interview 2: Approx 60 minutes, after classroom discourse data collection

Date and time of interview:

_____

Name of interviewee:

_____

Position at the school:

_____

Interview consists of viewing video data together and discussing teacher's views on the language being used for learning at selected moments in the videos.

Addendum 7: Transcript of Anna's chemical reactions video

Hi Phumeza,

my name is Anna

and I want to answer your question

which is 'what effect do chemical reactions have on our lives'

now I'm not a scientist

and uh the w- what I work in is public policy

so how governments set the rules they do which um enable our society to function

but the aspect of public policy that I work in is climate change policy

and climate change as you might well know is being caused by a chemical reaction

um, fossil fuels which are being stored under the ground in solid or liquid form like coal or pet- or a oil

um are being dug up um and burnt either in our cars or in our electricity generators to give us energy

and we're doing this very much faster than has ever happened in the history of our planet um this transition from a solid from a solid or liquid state into a gaseous state

so carbon is being um changed into carbon dioxide

and carbon dioxide has a kind of an effect like a blanket in our atmosphere if we have too much of it

so our carbon dioxide levels in the atmosphere are going up

and that's causing our earth to warm

and that's causing very strange weather to happen across the globe

and the work that I do is to try and help companies and governments and people to stop these chemical reactions

to stop changing the the coal and the oil into carbon dioxide

so whilst I'm not a scientist

and I I don't I've forgotten a lot of what I learnt about chemical reactions at school

I do know that this chemical reaction is what has given me my job

and um is also hugely affecting our lives

ok good luck.

Addendum 8a: Topics and activity types in the class lessons

(non-topic specific activities are shaded)

Lesson no.	Date of lesson	Content/topic	Main activity type	Start time on video (audio)	End time on video (audio)	Time (mins)	Time (secs)
1	110416	The structure of the Periodic Table	Review			34m20s (incl. 20 mins I missed)	2060
		The structure of the Periodic Table	Seatwork			26m30s	1590
2	120416	The structure of the Periodic Table	Check HW			3m44s	224
		The structure of the Periodic Table	Go over homework	(05:00)	(35:01)	30m48s	1848
		The structure of the Periodic Table: metals and non-metals	T exposition	(35:01)	(41:37)	14m:20s	860
		Compounds	Teacher exposition	(41:37)	(49:00)		
3	150416	Structure of the Periodic Table: first 20 elements	Testing	0.24097	(08:15)	11m40s	700
		Structure of the Periodic Table	Go over test	(08:15)	(25:05)	6m40s	400

		Names of compounds	Teacher exposition	(25:05)	(44:02)	19m00s	1140
		Names of compounds	Seatwork	(44:02)	(63:22)	18m40s	1120
4	180416	Names of compounds	Check homework				
		Names of compounds	Go over homework	13:45	(19:53)	3m34	214
		Representing reactions	Seatwork	14:48(19:53)	(40:05)		
			Go over seatwork	37:24 (40:05)	44:52 (47:30)		
			Seatwork	44:52 (47:30)	(63:42)	16m12	
5	190416	Representing reactions	Seatwork	09:00	34:43		
		Researcher questionnaire	Interruption	34:43			
6	220416		Check HW	(06:32)			
			Go over HW	10:40	40:50		
			Seatwork	40:50	63:00		
7	250416	Representing reactions	Check HW				
			Go over HW: pg 128, 10a, including exposition	07:30	58:36		
			Classroom business				
8	260416		Check HW			05m52s	
			Go over HW			45m47s	2747
			Go over HW			05m01s	301

9	290416	Names of compounds and representing reactions	Testing			36m34s	2194
		Balancing equations	T exposition			20m50s	
10	30516	Names of compounds and representing reactions	Check HW			5	
			Go over test			50m05s	3005

Addendum 8b: Topics and activity types in the study group meetings

(non-topic specific activities are shaded) **Study group no.**	**Date of lesson**	**Content/topic**	**Main activity type**	**Start on video (audio) (mins)**	**End (mins)**	**Time (mins)**	**Time (secs)**
1	50416	Science language, studying techniques, introduction to study group, names	True dialogue	07:13	32:17		
		Prior knowledge of chemical reactions	Seatwork	32:17	41:49	09:32	572
		Discussing writing in Xhosa	True dialogue	41:49	44:02		
		Learner questions	Seatwork	44:02	47:01	02:59	179

		Write down learner questions	Go over	47:01	53:09	06:08	368
			Classroom business	53:09	53:30		
		Wood-free coloured pencils	Seatwork/groupwork	53:30	58:59	05:29	329
		Pack away	Classroom business	58:59	59:21		
2	70416		Settling in				
			Classroom business				
		Study habits	True dialogue	17:17	23:08		
		Prior knowledge of chemical reactions	Seatwork	23:08	29:13	06:05	365
		Epistemology and feelings about this topic.	True dialogue	29:13	30:34	01:21	82
		Draw diagram and explain in Xhosa	Seatwork	30:34	50:35	20:01	1201
		Writing in Xhosa	True dialogue	50:35	56:00		
		Learner questions	Seatwork	56:00	62:18	06:18	378

		Learner questions	True dialogue	62:18	65:16	02:58	178
3	120416		Settling in				
		Wood-free coloured pencils	Teacher exposition/review	10:22	12:00	01:38	98
		Diagram of chemical reactions and Xhosa explanation	Seatwork	12:00	33:50	21:50	1310
		Writing in Xhosa	True dialogue	33:50	35:45		
		Number of elements in the periodic table	Teacher exposition/review	35:45	43:44	07:59	479
		20 elements test	Seatwork	43:44	51:32	07:48	468
		Periodic table song	Media presentation	51:32	54:17	02:45	165
		Names of elements	Teacher exposition/review	54:17	56:28	02:11	131
		Study habits	True dialogue	56:28	58:03	01:35	
		What is sulfur? What	True dialogue	58:03	66:41	08:38	518

		is mercury? Variations in periodic tables.					
		Social chat	Classroom business	66:41	68:27		
4	190416	Conversation with Mr J	Settling in	00:00	11:38		
		First 20 elements	Testing	11:38	16:45	05:07	307
		Study habits	True dialogue	16:45	21:08		
		Reflection on chemical reactions learning	True dialogue	21:08	22:54	01:46	106
		States of matter	Media presentation	22:54	25:54	01:00	60
		States of matter	Teacher exposition/review	25:54	31:51	05:57	357
		Balancing equations	True dialogue	31:51	32:21	00:30	30
		Self study balancing equations	Seatwork	32:21	44:54	12:33	753
		Balancing equations	Go over seatwork	44:54	62:26	17:32	1052

		Why do equations need to be balanced?	True dialogue	62:26	67:43	05:17	317
5	260416		Settling in	(00:00)	(12:04)		
		20 elements test	Testing	(12:04)	(16:31)	04:27	267
		20 elements test	Go over test	(16:31)	(19:03)	02:32	152
		Review of Khethiwe's question	True dialogue	(19:03)	(22:58)	03:55	235
		Reading and discussing 'Basic introduction to Chemistry' to find out about states of matter	External text dialogue	(22:58)	(24:38)	01:40	100
		Go over homework from class as nominated by Khethiwe.	Go over	(24:38)	(41:02)	16:26	986
		Robyn's method for writing a	T exposition	(41:02)	(48:00)	06:58	418

		chemical equation					
		Balance an equation	Seatwork	(48:00)	(48:23)	00:23	23
		Go over/ work through the balanced equation	Go over	(48:23)	(57:50)	09:27	567
		Balance an equation	Seatwork	(57:50)	(67:51)	10:01	601
			T exposition	(67:51)	(82:45)	15:54	954
			Classroom business	(82:45)	(85:17)		
6	280416	Settling in	Settling in	00:00	17:35		
		20 elements test	Testing	17:35	25:10	07:35	455
		Study habits	True dialogue	25:10	26:34	01:24	84
		Naming of compounds	Seatwork	26:34	29:55	03:21	201
			Go over seatwork	29:55	35:26	05:31	331
		Charging compounds	T exposition	35:26	45:06	09:40	580
		Balancing equations	Seatwork	45:06	47:16	02:10	130
			Go over seatwork	47:16	67:07	19:51	1191

7	30516		Settling in	(00:00)	(02:17)		
		Reflecting on test	True dialogue	(02:17)	(05:12)	02:55	175
		Organising seating	Classroom business	(05:12)	(09:36)		
		Learners' questions	T exposition and review	(09:36)	(31:45)	22:09	1329
		Size of an atom	Media presentation	(31:45)	(37:03)	05:18	318
		Balancing equations	Teacher exposition/review	(37:03)	(40:01)	02:58	178
		Class test	Go over test	(40:01)	(63:49)	23:48	1428
8	240817	Interview style questions about the topic, the study group and the class	True dialogue				
		The student questioning dialogue extract playback	Media presentation				
		Interview style questions	True dialogue				

		about the topic, the study group and the class					
		Translate definitions into English	Seatwork	(35:47)	(47:13)	12:26	746
		Translate definition into Esenginqi	Seatwork	(47:13)	(62:59)	15:46	946

Addendum 9a: isiXhosa parent letter

Iphepha le nkcazelo labazali

Mzali/Mnyamekeli womntwana obekekileyo,

Uphando ngokusetyenziswa kweeLwimi ezimbini kwiiklasi zeSayensi.

Igama lam ngu Robyn Tyler. Ndingumfundi kwiYunivesiti yaseKapa kwicandelo lezeMfundo; ndenza izifundo kwezobuGqirha ndijonge kwicandelo lemfundo. Ndingathanda ukucela imvume yakho yokwenza uphando ngokusetyenziswa kolwimi lokufundisa kwiklasi yeNatural Science afunda kuyo umntwana wakho.

Ndingathanda ukuqokelela inkcazelo ngokubakho kuzo zonke izifundo eziphathelele iNatural Science kwikota yesibini yalo nyaka. Ndingathanda ukurekhoda ngevidiyo izifundo ndize ndirekhode ilizwi likaTishala nelabantwana abafumene imvume kubazali babo. Kwakhona ndingathanda ukudlana indlebe nabambalwa kubafundi. Le vidiyo iza kusetyenziselwa izifundo zam kuphela, iintlanganiso neenkomfa esizibamba nabanye abenza uhlolisiso olufana nolu, ukub kunokwenzeka nokunceda ukuphucula umgangatho wokufundisa kooTishala. Ubuso babantwana abuzukuvezwa kuba ndizakubusitha bungabonakali kwividiyo. Isikolo ekwenziwa kuso uphando kwakunye negama lomntwana aziyi kuchazwa. Namagama abantwana nootishala aza kutshintshwa ukukhusela ukuba bangaziwa.

Nceda uzalise eli phecana lingezantsi ukubonisa ukuba uyavuma umntwana wakho athabathe inxaxheba kolu phando. Ukuthatha inxaxheba akunyanzeliswanga, yaye ungamrhoxhisa nanini na umntwana wakho kolu phando. Ukuba unemibuzo nceda uzive ukhululekile ukundifowunela okanye undithumelele i-imeyile.

Ozithobileyo,

Robyn Tyler

robynltyler@gmail.com

076 452 6954

Ifomu yokunikezela ngemvume- abazali

Uphando ngeelwimi ezininzi kwiklasi yeSayensi

Nceda uchaze enoba uyainikezela imvume yokuba umntwana wakhe abe yinxalenye yoluphando ngoku faka umbhalo wokumakisha (√) kwibhokisi ka "Ewe" okanye "Hayi" ecaleni kwayo yonke imibandela yolu phando. Emva koko nceda utyobele ngezantsi uze eli phecana ulunike uTishala weNatural Science.

Igama: (Printa)

(Tyobela)

(Umhla)

Igama lomntwana:

Nceda wenze uphawu kwenye yezi bhokisi ukubonisa ukuba uyayinikezela imvume yakho:

Ndiyamvumela umntwana wam:	**Ewe**	**Hayi**
1. Ukubukelwa ngoxa eseklasini.		
2. Ukufotwa ngevidiyo esebenza eklasini. Kuza kusetyenziselwa olu phando. (le vidiyo iza kubonwa ngumphandi, ngumhloli womphandi kunye noTishala)		
3. Ukufotwa ngevidiyo besebenza eklasini. Iza kuboniselwa kwiikomfa nabanye abanza uphando olufanayo.		
5. Udliwano ndlebe		
6. Xa bebhala umsebenzi weklasi.		

Addendum 9b: English parent letter

Parent Information Sheet

Dear Parent/Carer,

Research on Language in bilingual Science classrooms

I (Robyn Tyler) am a doctoral student in the School of Education at the University of Cape Town. I would like to ask your permission to carry out research on children's language use in your child's Natural Science class.

I would like to collect data by sitting in on all the class lessons relating to one topic in Natural Science in Term 2 2016. I would like to video-record the lessons that I observe and audio-record the teacher's voice and the voices of two learners from whose parents I will seek special permission. I would also like to interview a selection of learners. The video data will be used for my study, for academic workshops and conferences and potentially for teacher education and children will not be identifiable from the images I use as I will block out faces. Neither the school nor your child will be identified in the research – I will use different names (pseudonyms) for the school, teacher and learners.

Please fill in the slip below to show whether you give permission for your child to take part in the research. Participation is entirely voluntary and you may withdraw your child from the research project at any time. You are welcome to ask any questions regarding this research by telephone or email.

Yours sincerely,

Robyn Tyler

robynltyler@gmail.com

076 452 6954

Consent form- parents

Research on Language in bilingual Science classrooms

Please indicate if you give permission for your child to be part of the research by ticking yes or no next to each aspect of the fieldwork and signing your name below. Please return this slip as soon as possible to the Natural Science teacher.

Name: (Print)

(Signature)

(Date)

Child's Name:

Please tick the box to indicate your consent to each part of the research:

I consent to my child:	**YES**	**NO**
1.Being observed in the classroom		
2.Being video-recorded working in the classroom to be used for this study (to be viewed by the researcher, her supervisor and the teacher)		
3. Being video-recorded working in the classroom to be screened for academic workshops and conferences		
4. Being interviewed		
5. Having class work copied		